RESkill 4NetZero
Boosting Green Energy Careers

ReSkill4NetZero

(Deliverable 2.1)

Occupational Profiles and Needs Analysis

31/05/2025

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GLOSSARY

AI	Artificial Intelligence
BMS	Battery Management System
CAD	Computer-Aided Design
DER	Distributed Energy Resources
DCE	Communication, Dissemination and Exploitation
DMP	Data Management Plan
ESCO	European Skills, Competences, Qualifications and Occupations
EU	European Union
HMI	Human-Machine Interface
HVAC	Heating, Ventilation, and Air Conditioning
LLM	Large Language Model
LCA	Life Cycle Assessment
O&M	Operation and Maintenance
OSH	Occupational Safety and Health
PLC	Programmable Logic Controller
PV	Photovoltaic
QAP	Quality Assurance Plan
RE	Renewable Energy
RES	Renewable Energy Sources
RESP	Renewable Energy Skills Partnership
SCADA	Supervisory Control and Data Acquisition
SME	Small and Medium-sized Enterprise
VET	Vocational Education and Training
WP2	Work Package 2

WP3–WP6 Work Packages 3 through 6

Executive Summary & Structure of the document

The report *Occupational Profiles and Needs Analysis* offers a comprehensive overview of current and emerging workforce needs in the European renewable energy sector. It consolidates evidence from surveys, job board analyses, expert interviews, and industry reports reviews to identify the occupations and skills that are central to the success of the energy transition.

Findings show a consistently high demand for roles such as renewable energy technicians, energy and industrial engineers, HVAC and gas technicians, health and safety professionals, and maintenance operatives. These roles are considered essential across renewable energy sectors. Alongside these, several emerging and hybrid profiles are gaining prominence, including SCADA programmers, AI specialists, sustainability experts, and energy system planners. Interviews with industry stakeholders reinforced the urgency around these roles, highlighting growing talent shortages, especially for those combining technical depth with systems-level understanding.

The skills required across the sector reflect a blend of technical, digital, and transversal competencies. Foundational knowledge in engineering and energy systems remains critical, but employers increasingly seek candidates with digital capabilities such as data analysis, programming, and system integration. At the same time, transversal skills like project management, communication, and interdisciplinary collaboration are in high demand, particularly for roles that bridge technical and strategic functions. The report also notes emerging needs related to artificial intelligence, circular economy practices, and regulatory literacy.

An initial review of available training courses suggests that current provision does not yet fully reflect the evolving needs of the sector. While some programmes seem sufficiently well-aligned with labour market demands, others show limited coverage of emerging digital and interdisciplinary skills. Areas such as automation, system integration, and new energy technologies are not consistently addressed, indicating room for improvement in content and structure.

The report identifies several systemic challenges. Education and training systems often fail to keep pace with technological change, and vocational education is undervalued. SMEs in particular face barriers in accessing or delivering adequate training, and existing qualification frameworks do not always support cross-sector mobility or recognition of prior learning.

In response to these findings, the report recommends maintaining the existing set of 13 occupational profiles as a validated foundation, while expanding the framework to incorporate high-demand roles that currently fall outside the initial taxonomy, such as software developers, AI architects, quality assurance professionals, and operations managers. These additions would reflect the growing importance of digital and leadership functions in renewable energy deployment.

The accompanying skills framework is also set to evolve. The report recommends increasing the visibility of frequently requested skills such as programming and data analysis, and grouping these under more specific labels. It also calls for clearer representation of transversal competencies, including stakeholder engagement and team leadership, which are often critical to project delivery but not always foregrounded in training or profile definitions.

Looking ahead, the report suggests that training provision must become more modular, flexible, and accessible. This includes enabling micro-credentialing and expanding the availability of high-quality courses that are aligned with current and future skills needs. Improving the visibility and quality assurance of offerings at European level will also be key to supporting the workforce transition across diverse regions and sectors.

Overall, this report provides the analytical foundation for the RESkill4NetZero project's broader goal: equipping Europe's energy workforce with the right skills at the right time. By aligning occupational profiles, skill frameworks, and training systems with real market demands, it aims to support a more efficient, inclusive, and future-ready green transition.

1. Introduction

1.1. Work Package 2 (WP2)

The transition to a climate-neutral economy is a defining challenge of our time, and the renewable energy sector lies at its core. As the European Union advances toward its net-zero targets, the deployment of renewable energy technologies is accelerating, reshaping labour markets and generating new occupational demands. However, the speed and complexity of this transition have exposed a critical barrier: the lack of a sufficiently skilled workforce to design, install, operate, and maintain these systems at scale.

Addressing this challenge requires a clear and structured understanding of the skills needs and occupational profiles that underpin the renewable energy sector, today and in the future.

It is within this context that RESkill4NetZero was conceived: a coordinated European initiative to support the identification of skills gaps, the development of training strategies, and the promotion of sustainable careers in renewable energy. The project brings together education providers, industry stakeholders, and policy actors to co-develop an actionable roadmap for reskilling the European labour force for the energy transition.

As part of this broader objective, Work Package 2 (WP2) is dedicated to the identification and analysis of occupational profiles, skills needs, and training gaps in the renewable energy sector. WP2 provides the analytical foundation for subsequent work packages focused on developing training programs and certifications (WP3), implementing training programs (WP4), promote careers in the renewable energy sectors (WP5) and ensuring long term impact (WP6).

This document constitutes the first major output of WP2 and aims to provide a consolidated overview of the current state of knowledge regarding renewable energy occupations and their associated skills and competences. In doing so, it responds to the need for a coherent and evidence-based framework upon which education providers and industry actors can base future initiatives.

1.1. Goals and Needs

The initial phase of Work Package 2 focuses on addressing this need by analysing and validating a preliminary set of roles and skills that were identified during the project preparation phase. These pre-selected profiles serve as a starting point for structured analysis, grounded in job boards data collection, stakeholder interviews, sectoral studies, and surveys conducted in 2023 and 2025.

The work carried out in this first year does not aim to redefine the landscape from scratch, but rather to build on this initial selection to ensure it remains relevant, comprehensive, and future-oriented. The goal is to validate, complement, and expand the existing list in light of current labour market dynamics and the anticipated evolution of the sector.

This foundational analysis supports the broader objective of Work Package 2: to provide a clear, evidence-based picture of the occupational and skills needs of the renewable energy workforce across Europe. It will directly inform the development of a Renewable Energy Skills Strategy by identifying the gaps in occupational profiles and competences in the current market, as well as those likely to grow in importance as the sector evolves.

1.2. Definitions

To ensure coherence with European frameworks and support the uptake of project outcomes at policy, education, and labour market levels, the RESkill4NetZero consortium has adopted the ESCO (European Skills, Competences, Qualifications and Occupations) classification as a reference taxonomy.

ESCO provides a multilingual structure for identifying and organising occupational profiles and related skills across sectors and educational levels. It supports comparability of qualifications, mobility of learners and workers, and the development of skills intelligence tools across the European Union.

As part of Deliverable D2.1, the consortium conducted a two-tiered matching exercise, linking:

The 13 occupational profiles defined in the Grant Agreement to the corresponding ESCO occupations, as listed below:

Government:

1. Planners – white collar professionals

This category of workers includes urban planners, energy managers and regulators, who need to be trained on all aspects of RES technology, installation best practices, resource monitoring and management, with a view of promoting sustainable integration of renewable energy resources in energy planning strategies and local development.

Engineering:

2. Renewable Energy Consultants - white collar professionals

The occupational profile for this role involves an engineer specialized in designing renewable energy plants, including solar, wind, geothermal, and hybrid projects. This professional is responsible for selecting plant locations, determining panel orientation, and designing geothermal heat pump systems with a consideration for geological aspects. Knowledge of the permitting process across all renewable energy sources (RES) is crucial. With the growth in renewable projects, there's a need to both train and attract more engineers and high-level STEM professionals into renewable energy careers. Planning engineers also play a key role in ensuring the effective delivery of heat pump installations in multi-family and commercial buildings.

3. Energy Engineers – white collar professionals

Energy Engineers in the renewable sector are increasingly required to upskill in emerging areas such as circularity of renewable energy technologies, digitalization and new business ecosystems, transition

management, systemic thinking, and leadership. These professionals must adapt to new technologies, explore innovative business models, and look beyond traditional financing streams. Upskilling in these areas is crucial for addressing the complexities of renewable energy projects and leading the sector towards sustainable and efficient energy solutions.

Manufacturing:

4. Factory Operatives / Maintenance – blue collar professionals

Factory Operatives and Maintenance professionals, categorized as blue-collar workers, are pivotal in the production of new clean technologies, such as solar PV modules. These roles span across all skill levels, from operators to technicians, and there's a notable demand in sectors like solar PV module factories in Germany. The need emphasizes the importance of staffing in manufacturing facilities for clean technologies, underscoring a critical area for workforce development and training to meet the industry's growing demands.

5. Industrial Engineers - white collar professionals

Industrial Engineers in the clean technology manufacturing sector are essential for researching new technologies, designing industrial products, and managing factories with Industry 4.0 technologies.

Electrical:

6. Electricians (Domestic) – grey collar professionals

Domestic Electricians, classified as grey-collar professionals, face a structural shortage due to multiple factors including the unattractiveness of VET, misconceptions about technical careers, and issues with training centres such as capacity, funding, and distribution. Addressing the gender dimension is also crucial. Modern electricians need to evolve into "system integrators" with skills in integrating Distributed Energy Resources (DER) technologies and Power-electronic devices like smart inverters and digital tools like Human Machine Interface (HMI). The training landscape, including public and company-provided courses, requires evaluation for adequacy and alignment with industry needs. Additionally, distinguishing between low and high voltage electrician profiles is necessary due to differing skill sets required for residential installations versus large-scale wind and solar PV farms.

7. Industrial Electricians – grey collar professionals

An Industrial Electrician is a specialized role focusing on the installation, maintenance, and repair of electrical systems in industrial settings. This professional is adept at working with high-voltage systems, programmable logic controllers (PLCs), and other complex machinery found in manufacturing plants, power plants, and other industrial facilities. They ensure these systems operate efficiently, safely, and in compliance with regulatory standards. Continuous education on emerging technologies and safety protocols is crucial for Industrial Electricians to adapt to the evolving demands of the industry.

Technicians

8. Renewable Energy Technicians (wind / solar / geothermal / heat pumps) – blue collar professionals

Renewable Energy Technicians, encompassing wind, solar, geothermal, and heat pump specialists, are pivotal blue-collar professionals in the green energy sector. Their roles span from conducting environmental-safe drilling and installing borehole heat exchangers to welding pipes and setting up control systems. Heat Pump installers, as detailed in the HP4All Project, require a blend of technical, customer-oriented, and business competencies. The sector offers significant reskilling/upskilling opportunities for those transitioning from fossil fuel industries. The demand for these technicians is growing, highlighting the need for standardized training to quickly upskill and reskill workers, addressing the industry's rapid expansion and quality requirements.

9. Gas technicians (biogas / hydrogen)

Gas Technicians specializing in biogas and hydrogen play a pivotal role in renewable energy, focusing on the installation, maintenance, and monitoring of gas systems. They ensure these systems operate efficiently, safely, and in compliance with environmental standards. Their expertise supports the sustainable production and use of biogas and hydrogen as alternative energy sources, contributing to energy diversification and decarbonization efforts. Continuous training on emerging technologies and safety protocols is essential to meet the sector's evolving demands.

10. HVAC and refrigeration technicians

HVAC and Refrigeration Technicians are specialized professionals in the renewable energy sector focused on the installation, maintenance, and repair of heating, ventilation, air conditioning, and refrigeration systems. They play a crucial role in integrating new technologies into existing systems, ensuring energy efficiency and environmental compliance. These technicians are also vital in the wind energy sector, particularly in maintaining and cooling generators. The profile emphasizes the importance of continuous education, adaptation to new technologies, and the expansion of professional attractiveness to meet the evolving demands of the industry.

Operations

11. RE Power Plant operators – grey collar professionals

RE Power Plant Operators, categorized as grey-collar professionals, are highly skilled workers responsible for the operation and maintenance (O&M) of renewable energy (RE) power plants, including large-scale projects and manufacturing facilities.
Their role demands proficiency in programming industrial computers and sensors, particularly in SCADA systems and PLCs, essential for the efficient and safe operation of facilities like biogas plants. Continuous monitoring and frequent training are crucial to stay abreast of emerging technologies and O&M best practices, ensuring the uninterrupted operation of renewable energy plants.

12. Health and Safety Professionals – grey collar professionals

Health and Safety Professionals in the renewable energy sector, classified as grey-collar professionals, face unique challenges due to the complexity of large-scale RE systems and harsh operating environments. This job role, requiring specialized expertise, particularly in areas like refrigerant leak detection in heat pumps and overseeing permits and safety in wind projects, needs enhanced attractiveness. Efforts to retrain professionals, such as chimney sweepers transitioning to heat pump experts, illustrate the evolving nature of health and safety roles within the renewable energy industry.

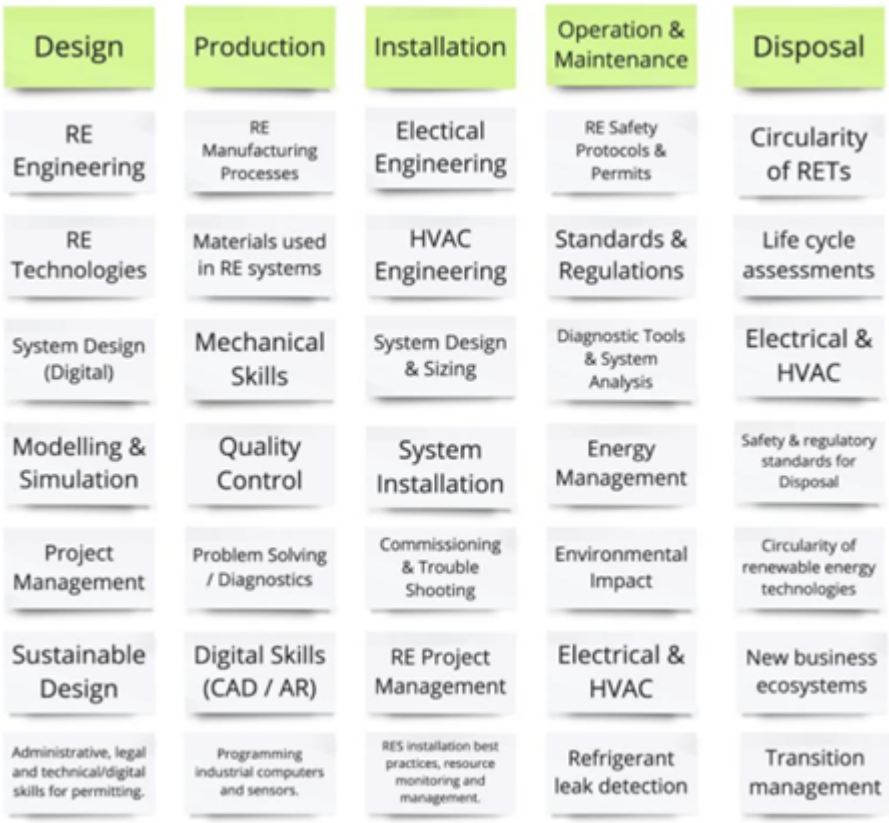
Disposal & Recycling

13. Critical Raw Material recovery

The Critical Raw Material Recovery Specialist is a professional focused on the sustainable extraction, recycling, and recovery of essential raw materials used in various industries, including renewable energy. This role involves identifying and implementing innovative methods to reclaim materials like rare earth elements critical for technologies such as wind turbines and solar panels. The specialist works to minimize environmental impact, ensure supply chain resilience, and support the transition to a circular economy. Their work is crucial for reducing dependency on virgin materials and enhancing the sustainability of technological advancements. Equally important is the mitigation of environmental and safety risks associated with hazardous waste and residual materials, which must be managed carefully to avoid soil, air, or water contamination during recovery processes.

The set of skills and competences associated with those roles to ESCO skills and knowledge concepts, addressing 5 core areas, as shown in figure 1:

Figure 1: Five Core skills categorised by area



1.3 Matching of Skills and Competences

In parallel, the project has matched each skill or competencies to one or more ESCO skills. The matching prioritised semantic precision, practical relevance, and policy alignment, and draws upon the ESCO hierarchy of knowledge, skills, and competencies. Where a given skill was matched to multiple ESCO entries, all relevant connections were retained and justified. The goal is to ensure that when training programmes are developed (under WP3 and WP4), they can be anchored to established EU frameworks.

1.4. Methodology

As mentioned before, the objective of the first-year analysis is to validate and complement the occupational profiles initially defined by the project, and to do so in an agile way, given the urgency of addressing emerging skills needs across the European renewable energy sector. To meet this objective, we adopted a multi-source approach that combines both automated and manual techniques, ensuring that the outputs are empirically grounded, semantically aligned, and actionable in the short term.

The methodology was structured in two stages:

- Data Collection and Processing: Applying tailored methods to each source of information (industry reports, job ads, surveys, interviews, training programmes).
- Synthesis and Integration: Combining and cross-validating findings across sources to assess the validity and relevance of each occupational profile and its associated skills and complement them if needed.

1.4.1 Data Collection and Processing

Desk Research on Industry Reports

A corpus of 36 strategic and technical documents covering renewable energy sectors and workforce needs was reviewed. To process this unstructured text efficiently, an AI-powered pipeline based on GPT-4o (a Large Language Model, LLM) was used. Key steps included:

- Extraction of roles, skills, sectors, and training needs.
- Semantic matching of extracted content to the ESCO taxonomy using Neofuzz (cosine similarity), sentence-transformers, and cross-encoders.
- Aggregation and tagging of results by country and sector.

This enabled the scalable identification of role/skill references and allowed alignment with European classification systems.

Workforce Surveys (2023 and 2025)

Two pan-European surveys were conducted to capture insights from stakeholders in industry, education, and policy:

- 2023 Survey: 154 responses from 21 countries.
- 2025 Survey: 34 responses from 14 countries.

Both surveys included quantitative components (e.g. Likert scales, multiple-choice questions) and qualitative fields (free text responses). These were analysed using statistical summaries for closed questions and thematic coding for open comments, with a focus on identifying perceived skill gaps and urgent recruitment challenges.

Job Market Analysis via Job Boards

Over 70,000 job advertisements were scraped and analysed, of which 42,073 were retained after being cleaned and filtered by relevance. The analysis involved:

- Named entity recognition to extract job titles, skill keywords, and technology mentions.
- Normalisation of skill terms using ESCO mappings.
- Frequency analysis to assess demand signals across roles and regions.
- Comparison against the project's occupational profiles to identify matches, gaps, and variant terminology.

This provided a real-time view of labour demand in the sector.

Expert Interviews

Nine semi-structured interviews were conducted with experts spanning solar, wind, hydrogen, biogas, and energy systems. Experts were selected based on their cross-sectoral knowledge and seniority. The interviews were transcribed and analysed through a qualitative coding framework that surfaced:

- Emerging roles and technologies;
- Skills perceived as lacking in the current workforce;
- Barriers to recruitment and training.

This helped to contextualise quantitative data with operational and strategic insights from the field.

Training Offer Mapping and Quality Assessment

A total of 89 training courses were identified across Europe, mapped to technologies and countries. Each course was evaluated against a quality scoring rubric comprising four dimensions:

- Relevance to top 20 identified skills, and the top 5 skills of the top 20 identified job roles (40%);
- Methodology, including interactivity and hands-on training (25%);
- Alignment with standards or certification frameworks (25%);
- Accessibility (10%), e.g. cost, language, digital format.

Scores were normalised and synthesised to assess where training provision is well-developed or misaligned with demand.

Synthesis and Integration of Findings

Once each data stream was independently analysed, a structured synthesis process was applied to combine them into a unified evidence base. This approach ensured that each occupational profile and associated skill set was evaluated based on converging evidence from different perspectives.

Each occupational profile was assessed against all data streams. A profile was considered validated when:

- It appeared frequently in job advertisements;
- It was prioritised by respondents in surveys;
- It was cited in industry documents;
- It was confirmed or elaborated on in expert interviews.

This triangulation method ensured that conclusions were not drawn from a single data point, but from a consistent pattern across sources.

Where gaps were identified, for example, profiles that appeared in interviews or job ads but not in the original project list, these were flagged as candidates for inclusion. This allowed for data-driven expansion of the occupational framework.

Cross-Mapping to ESCO and Skill Aggregation

Skills extracted from each stream were mapped to ESCO concepts, enabling semantic consolidation. Where divergent language or localised terminology was found (e.g. “solar installers” vs. “PV fitters”), automated and manual reconciliation was used to group them under shared concepts. This process ensured terminological alignment across disparate sources.

Conclusion

This methodological framework was designed to respond to the time-sensitive nature of skill gaps in the renewable energy sector. Rather than starting from scratch, the project built upon an existing set of occupational profiles, using this approach to validate their current relevance and enhance them with market-driven evidence.

By combining multiple types of data, structured and unstructured, human and machine-processed, quantitative and qualitative, the consortium produced a set of findings that are empirically robust. This evidence base provides a solid foundation for the subsequent design and implementation of training interventions and certification pathways in Work Packages 3 to 6.

2. Industry Reports and Forecasts

2.1. Objectives

This phase of the analysis focused on identifying how occupational profiles and skills are represented in recent industry and market reports, and how these references are distributed across energy sectors and European countries. The goal was to extract structured insights from a diverse set of documents to support the validation and refinement of the project's initial assumptions regarding workforce needs in the renewable energy transition.

By applying an automated processing pipeline to a corpus of 30 reports (see list of references at page 61 for details of the reports), the analysis aimed to determine which occupational roles and skill requirements are most frequently mentioned across different renewable energy technologies. How these roles and skills are discussed in relation to specific countries or regional contexts. And what signals may point to emerging trends, including the evolution of existing roles or the introduction of new competencies.

Considering the reports included in the analysis, they represent a balanced variety of sectors within renewable energy, and countries. Tables 1 and 2 provide a summary of sectors and countries covered in the reports:

Table 1. Number of reports by sector

Sector	Number of reports
Renewable Energy	8
Green sector	4
Solar PV	4
Biogas	3
Wind	7
Electrical/Batteries	2
Hydrogen	2
Geothermal	1
Total	**31**

Table 2: Number of reports by country

Country	Number of reports
Wider Europe	21
Sweden	1
France	1
Ireland	1
Poland	1
Germany	2
UK	1
Austria	1
Slovakia	1
Spain	1
South Africa	1
Total	**31**

Rather than drawing broad conclusions about the labour market, this component provides an empirical, document-based view of how workforce needs are framed in current strategic and technical discourse. It supports the broader aims of Work Package 2 by helping to prioritise profiles for further analysis and by grounding subsequent findings in a diverse and representative evidence base.

2.2. Methods and Inputs

To process a large volume of unstructured documents in a systematic and scalable way, the project employed an automated data pipeline powered by a large language model (LLM). This pipeline was designed to analyse the full set of 36 reports and extract structured insights relevant to occupational and skill needs in the renewable energy sector.

Each report was processed to extract mentions of specific renewable energy technologies and sectors, geographic coverage and country-specific references, statements related to workforce needs, skills shortages, or emerging job roles and forward-looking forecasts and growth expectations tied to occupational demands. The outputs were then consolidated into a structured dataset to support sector prioritisation and validate the relevance of key occupational profiles.

The first stage of processing used GPT-4o to summarise the reports and extract relevant skill terms directly from the full content. These extracted terms were then matched against the ESCO taxonomy using a multi-step process. First, a fuzzy string-matching step was applied using the open-source Neofuzz library to account for small variations in terminology. Remaining terms were embedded using the sentence-transformer model all-mpnet-base-v2, which calculates semantic similarity between the extracted terms and ESCO entries. For each term, the 20 most similar

ESCO skills were identified, and a final validation step was performed using a cross-encoder model (ms-marco-MiniLM-L-6-v2) to select the best contextual match.

This approach allowed for consistent and semantically accurate mapping of diverse language found in the reports to a common reference framework, improving comparability and ensuring alignment with existing European skill classification standards.

2.3 Analysis: Occupational Profiles Confirmed in the Reports

Among the initial occupational profiles list, several emerged consistently across the analysed industry and market reports, reinforcing their relevance in the current and future renewable energy labour market. Renewable Energy Technicians, spanning wind, solar, geothermal, and heat pump specialisations, were the most frequently cited profile, appearing in twelve instances as being in high demand across various national contexts. This reflects the growing need for technical implementation capacity within the sector. As part of the analysis process, a range of original terms were grouped under this profile, including *PV installers (rooftop and utility)*, *wind turbine technicians*, *O&M technicians*, *blade maintenance workers*, *geothermal drillers*, *HVAC and SHK installers*, and *heat pump engineers*, each referenced as specific workforce needs in the reviewed reports.

Gas Technicians (Bio Gas / Hydrogen) were notably in demand, with eight occurrences linked to critical roles such as *pipeline technicians*, *CHP technicians,* and *biomethane injection specialists*. These professionals play a vital role in ensuring the safe and efficient operation of gas systems within renewable energy infrastructures, including biogas and hydrogen networks. Their expertise supports the production, distribution, and maintenance of renewable gas technologies essential for the energy transition.

Energy Engineers were cited seven times as being in demand across various technologies, with references to profiles such as *solar system designers*, *SCADA engineers*, *electrolysis engineers*, *battery management system (BMS) engineers*, and *energy system designers*, signalling the growing need for interdisciplinary engineering expertise across digital, thermal, and electrical domains.

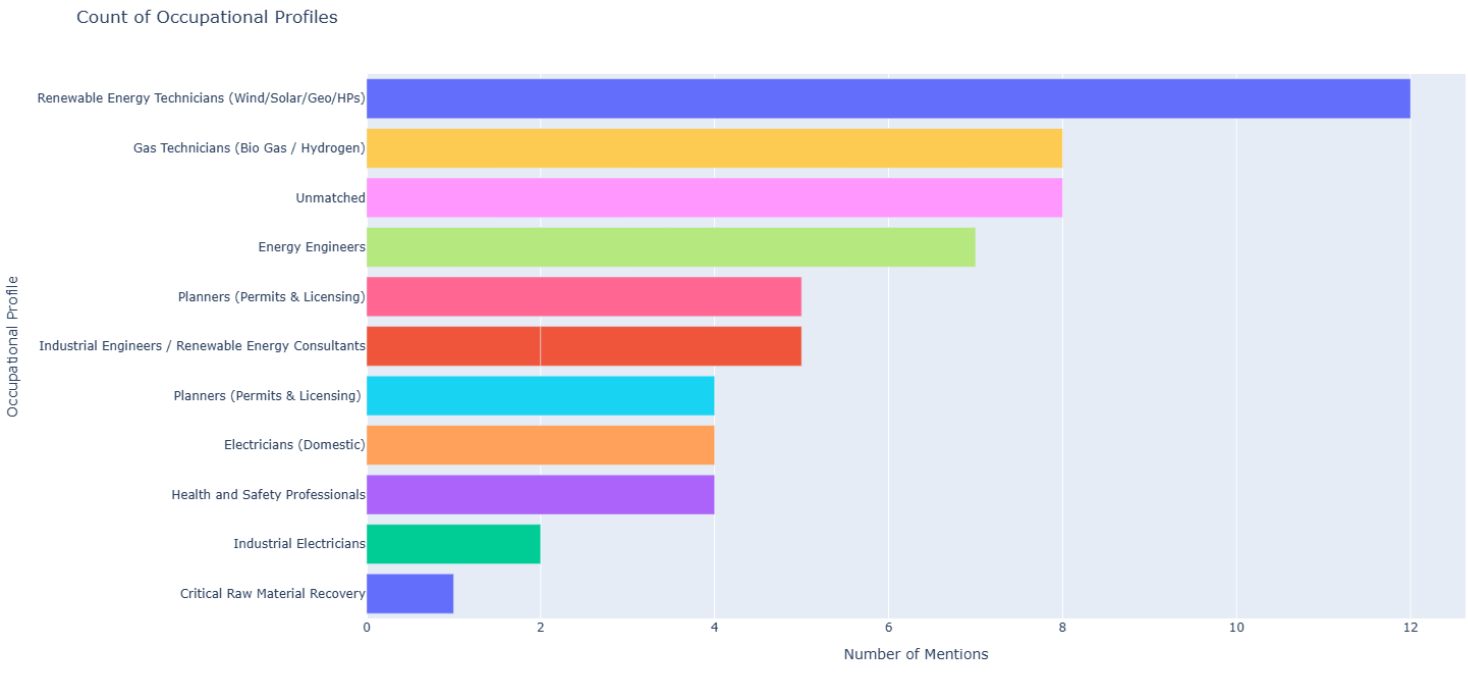


Figure 2: Count of Occupational Profiles

2.4 Geographic Distribution of Role Demand

Germany distinctly shows a strong demand for *Hydrogen Project Managers* alongside a high frequency of *Gas Technicians (Bio Gas / Hydrogen)* and *HVAC and Refrigeration Technicians*. It also uniquely highlights roles such as *Roofers*, *Welders*, and *Battery Cell/Pack Assemblers*, underscoring its advanced renewable manufacturing and hydrogen infrastructure development. **France** stands out for its emphasis on *Battery Cell/Pack Assemblers* and *Agricultural Logistics Coordinators*, reflecting the integration of manufacturing and bioenergy supply chains, alongside core technical roles. **Ireland** is notable for a focus on *Offshore Marine Crew* and repeated mentions of *Renewable Energy Technicians* and *Project Managers*, signaling a robust offshore wind and renewable operations sector. **Slovakia** is remarkable for combining *Planners (Permits & Licensing)* with *Retrofitting Experts* and *Battery Cell/Pack Assemblers*, illustrating a diverse blend of regulatory, technical, and manufacturing workforce needs. **South Africa** distinctly highlights a growing demand for *Project Managers*, *Renewable Energy Consultants*, and *Retrofitting Experts*, indicating an expanding and maturing renewable energy market with both technical and strategic skill demands. **Spain** uniquely features *Roofers* and *Welders* prominently alongside *Renewable Energy Technicians* and *Offshore Marine Crew*, reflecting active solar and wind infrastructure coupled with specialized construction and maintenance skills.

These insights point not only to which roles are central to the energy transition but also to where those needs are emerging most acutely, offering a basis for regional prioritisation and the targeted design of training interventions.

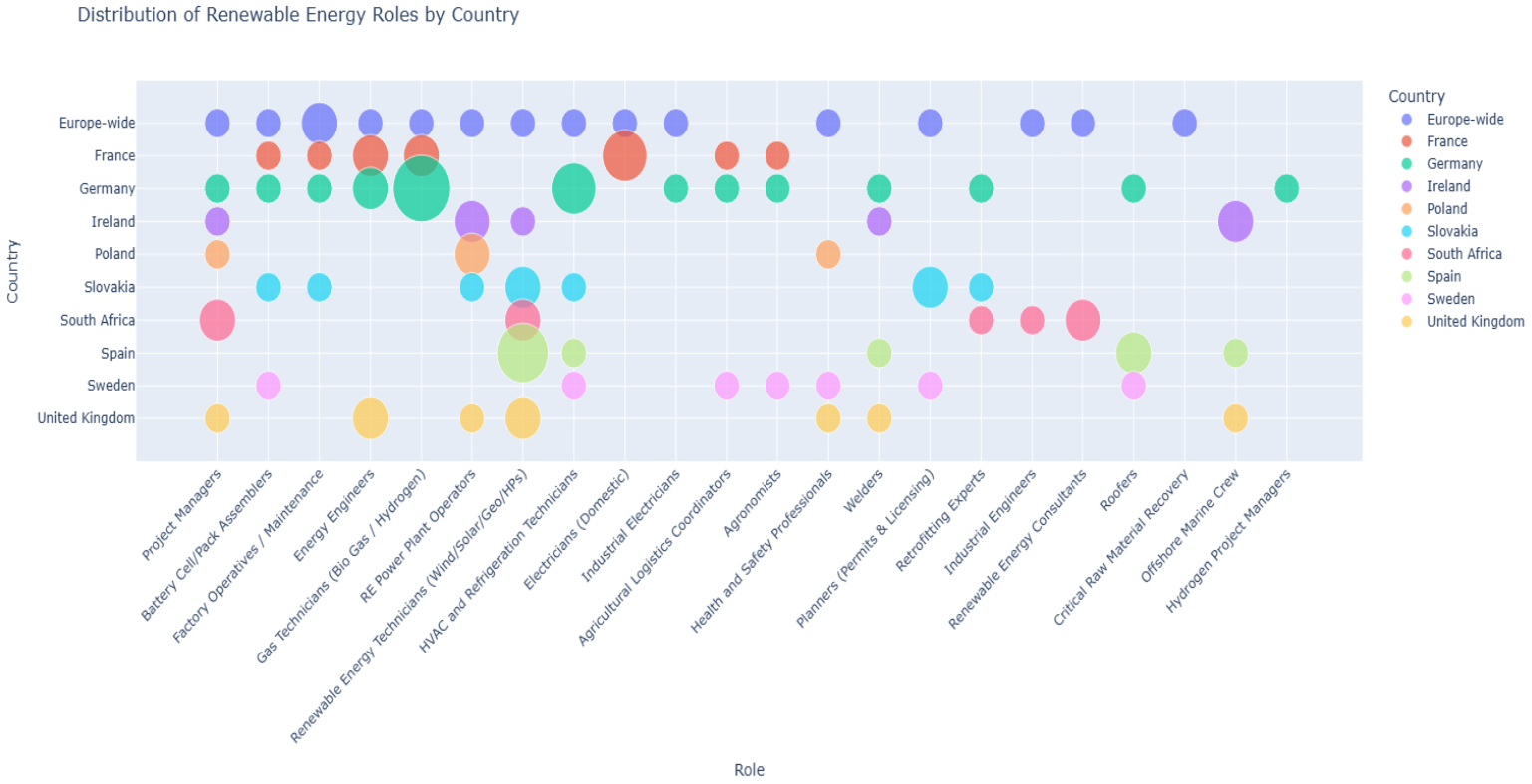


Figure 3: Distribution of Renewable Energy roles by Country

2.5 Additional Roles Not Originally Included

In addition to the predefined occupational profiles, the analysis surfaced a set of roles that do not align directly with the initial list but were nonetheless reported as in demand across multiple reports and national contexts. These findings suggest that the scope of relevant workforce categories may be broader than initially assumed and that some critical functions in the renewable energy transition may be underrepresented in the original framework.

- **Project managers** were also identified as essential, particularly for coordinating large-scale offshore wind and hydrogen projects. While managerial roles were not explicitly defined in the tender, their inclusion may be valuable for recognising cross-cutting operational competencies.
- **Offshore marine crew**, such as technicians, vessel operators, and logistics staff, were cited in reports focused on offshore wind infrastructure. These roles fall outside the typical boundaries of energy-specific training but are crucial in enabling safe and efficient deployment.
- **Welders**, mentioned in relation to turbine blade repair and structural assembly, and may warrant inclusion as a support profile for manufacturing and maintenance-intensive technologies.
- In the context of battery production, **battery cell and pack assemblers** were reported as emerging technical roles in several countries. Although not yet captured in the original profile list, they can be considered for inclusion as subcategories under Factory Operatives.
- **Agricultural logistics coordinators** and **agronomists** appeared in connection with bioenergy and feedstock supply chains. These roles fall outside core energy occupations but may be relevant in integrated sector pathways.
- Finally, **retrofitting experts**, mentioned in relation to building energy renovation and heat pump deployment, represent a hybrid profile combining construction, energy efficiency, and installation skills. While ESCO does not currently list a single term for this profile, it may be approximated through a combination of *"Energy efficiency technician"*, *"Building retrofit technician"*, and *"Construction supervisor"*, suggesting a potential area for ESCO refinement or custom tagging.

These roles highlight important operational, technical, and cross-sectoral functions that support the renewable energy transition but may require further refinement of the project's occupational taxonomy. Their inclusion in subsequent matching and analysis phases would ensure a more complete and representative foundation for skills strategy and training design.

3. Surveys

3.1. 2023 Statistical Report on Skills Needs in the Renewable Energy Sector

3.1.1 Objectives

The survey analysed in this report was conducted in 2023 across the European renewable energy sector, aiming to assess current workforce capacities, skills shortages, and future training needs. Specifically, the survey intended to:

- Identify key job roles within renewable energy sectors.
- Map recruitment challenges and labour shortages.
- Highlight knowledge and skills gaps.
- Forecast future job roles and competencies.
- Inform training curricula and workforce policy through sector-level evidence.

The survey included both structured quantitative tables and open qualitative responses.

3.1.2. Methodology

Data was collected from companies, research organisations, and academic institutions. Respondents provided information on job profiles, training practices, skills gaps, and future outlooks. Responses were classified as follows:

Quantitative tables were used for questions related to job profiles, recruitment difficulty, skill gaps, anticipated job openings, critical future competencies, and transferable skills. Open-ended qualitative responses were analysed for questions addressing company context, training practices, growth drivers, and policy recommendations. This approach enabled both statistical clarity and contextual depth.

3.1.3. Respondent Demographics

Survey respondents represented a wide geographic and organisational spectrum. Countries included Germany (12), Netherlands (8), Spain (8), France (3), Ireland (6), United Kingdom (4), Norway (4), Switzerland (4), Portugal (3), Italy (3), Croatia (2), Belgium (2), United States (2), Austria (1), Denmark (1), Sweden (1), Finland (1), Latvia (1), Lithuania (1), Luxembourg (1), Hungary (1).

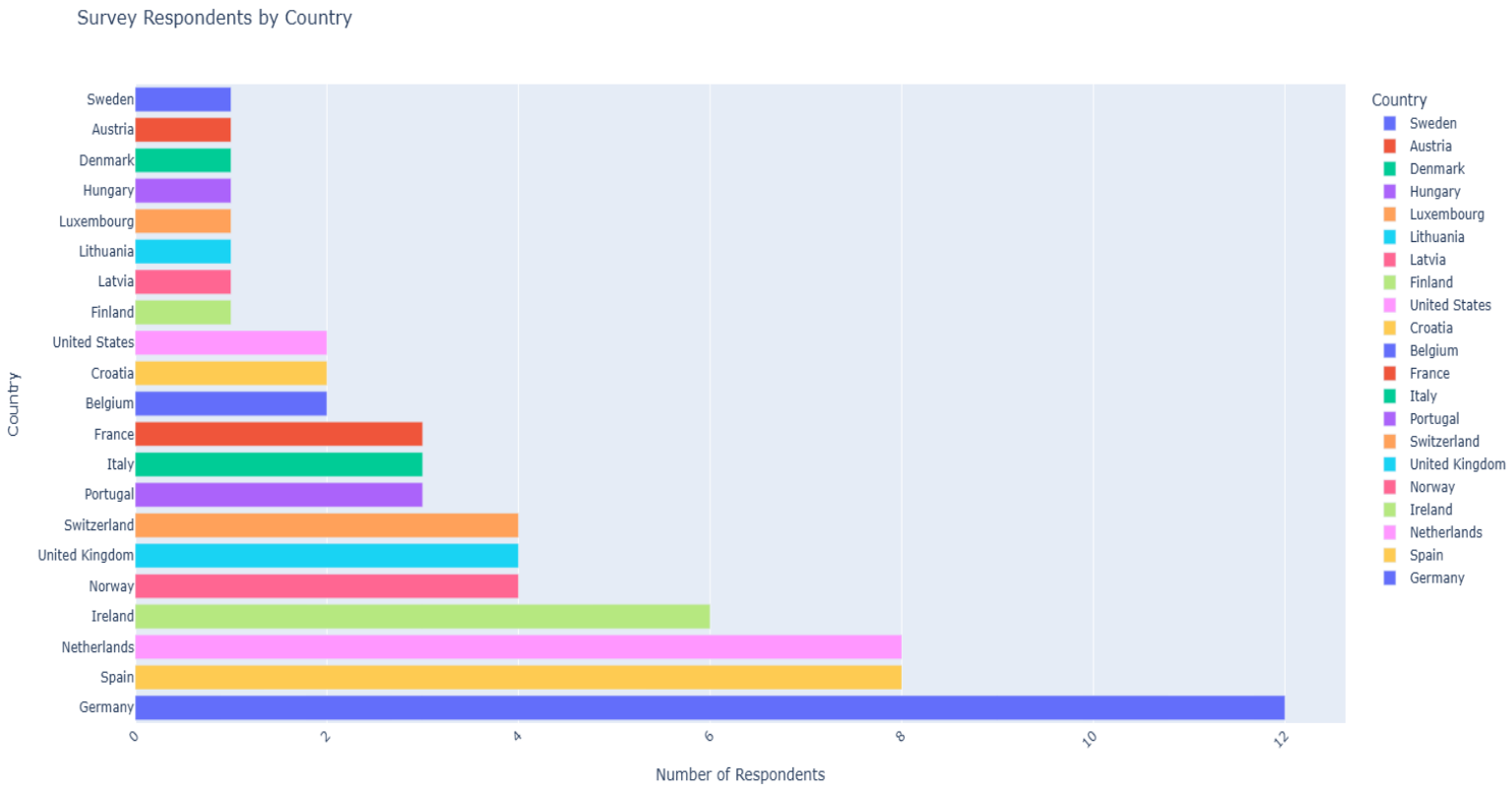


Figure 4: 2023 Survey Respondents by Country

Organisation types covered industrial firms, SMEs, research centres, and universities, with staff sizes ranging from micro-enterprises to large corporations exceeding 6,000 employees. Value chain positions spanned biogas production, processing, grid integration, certification, and operational support.

3.1.4 Quantitative Findings

The data from the quantitative tables revealed key insights into the occupational needs and emerging skills across the renewable energy sector, particularly biogas.

Job Profiles (Q5)

Out of 154 entries, 73 were successfully matched to pre-identified roles based on the project tender, while 81 entries represented new and some unmatched job profiles. Among the matched roles, the most frequently cited were Industrial Engineers (20), Renewable Energy Consultants (15), Factory Operatives/Maintenance (11), and Planners (10). The unmatched roles can possibly reflect an increasingly hybrid landscape, where titles such as Marketing and communication, Business Developer, Data Analyst, and R&D Engineer merge domain expertise with cross-functional coordination.

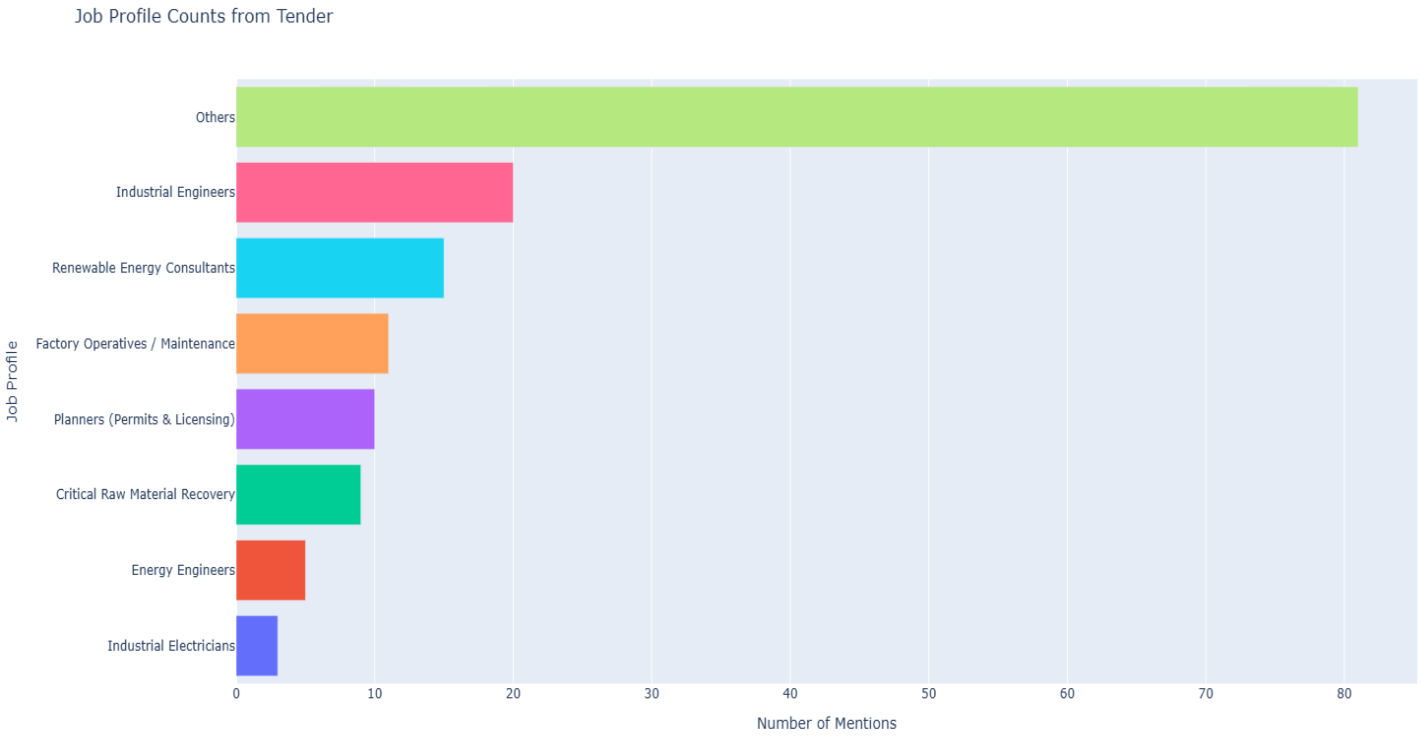


Figure 5: 2023 Survey: Answers to question 5.

Hard-to-Fill Positions (Q8)

In total, 105 job roles were noted as difficult to fill. While 44 entries corresponded with pre-identified roles, 61 were listed as "Others," which could indicate a broader spectrum of labour shortages than previously captured. New titles include Software Developers, Geotechnical Specialists, Marine Surveyors, and Mechatronics Engineers. The most cited already identified roles were Industrial Engineers (14), Renewable Energy Technicians (9), and Planners (8), affirming these as structural bottlenecks in workforce availability.

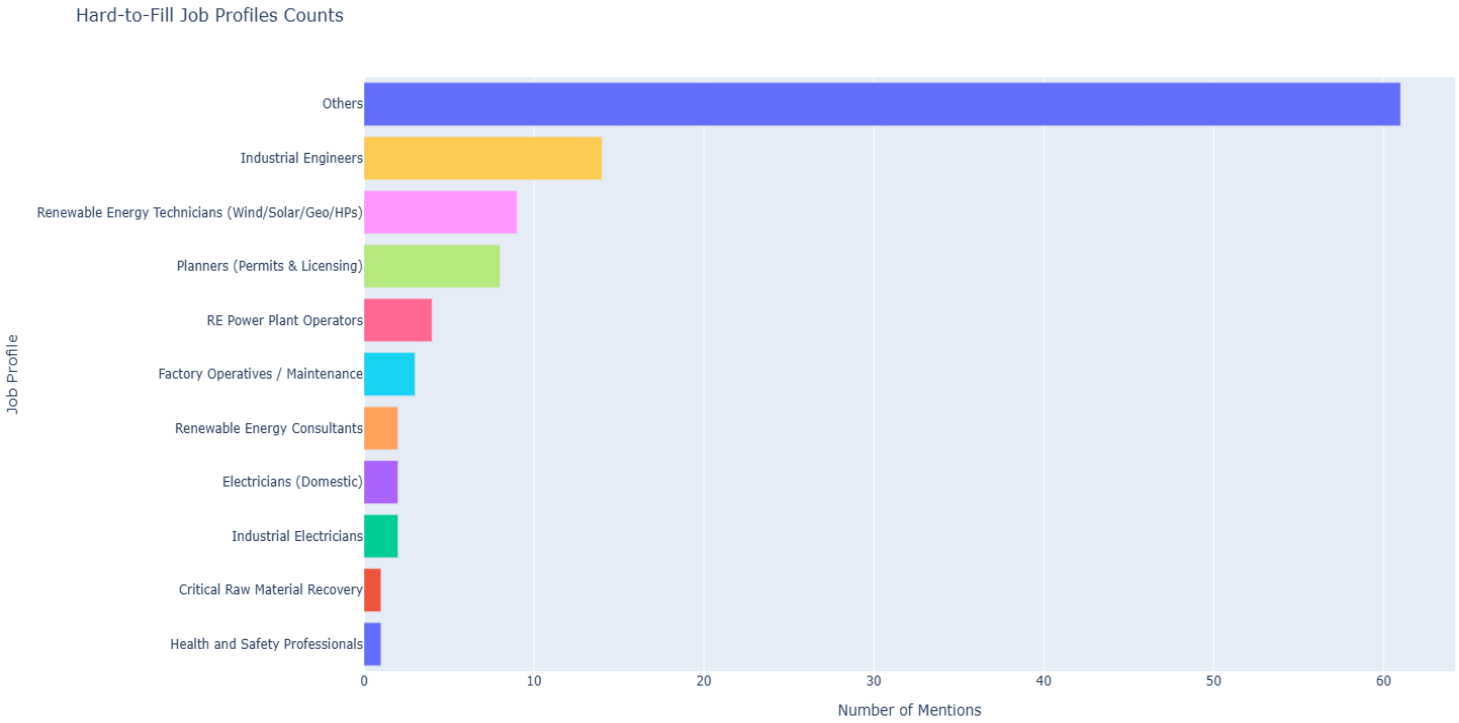


Figure 6: 2023 Survey: Answers to question 8.

Skills and Knowledge Gaps (Q11)

Among the 27 responses, several pointed to gaps that align with existing categories in the initial framework. These included "heat knowledge," which corresponds to HVAC Engineering; "data analysis" and "digital security expertise," which fall under Digital Skills; "design of industrial solar thermal systems" and "competence to prescribe solar in technical specifications," both of which relate to System Design and Sizing; "overall solar technology knowledge," which fits under RE Technologies; "knowledge of regulatory framework for digestate," which maps to Standards and Regulations; "sustainability assessment," which aligns with Life Cycle Assessments; and "health and safety knowledge," covered by RE Safety Protocols.

Other responses, however, reflected gaps not currently included in the initial list. These included automation technology, problem-solving with digital tools, hydrogen systems, circular economy practices, and sector-specific regulatory knowledge. The emphasis on digital-physical integration was also a recurring theme, suggesting that evolving system complexity is creating new skill demands beyond those initially identified.

Anticipated Roles and Skills (Q12)

Survey respondents foresee the creation of new job roles within their organisations, with several profiles expected to gain prominence in the near future. Among these, the most commonly cited roles are i**ndustrial engineers, factory operatives or maintenance personnel, renewable energy consultants**, and **energy engineers**. These roles were not only frequently mentioned but were also accompanied by detailed descriptions of the skills required to fulfil them effectively.

Industrial engineers are expected to bring expertise in system design, quality control, process optimisation, and the integration of electrical and mechanical components within renewable energy systems. Their role is seen as central to managing the complexity of manufacturing and operational processes in a rapidly evolving energy landscape.

Factory operatives and maintenance staff are increasingly associated with a broad range of cross-functional skills. These include inventory and logistics coordination, adherence to safety protocols, planning and organisational

capacity, and soft skills such as communication, teamwork, and time management. The inclusion of such attributes points to a shift in expectations for this category of workers, from task-specific operatives to multi-skilled contributors in modernised facilities.

Renewable energy consultants are expected to combine technical competence with client-oriented communication and project coordination. Their anticipated responsibilities include advising on system design, ensuring compliance with regulatory frameworks, and managing international project contexts.

Energy engineers are linked with advanced technical knowledge in thermal systems, hybrid energy solutions, and lifecycle analysis. Their expected contributions extend beyond design to include operational efficiency and the strategic integration of various energy technologies.

Beyond these core profiles, other roles such as HVAC specialists, field service engineers, and project managers are projected to gain importance. They are associated with critical competencies including fluid dynamics, heat transfer, commissioning expertise, and risk management.

The associated skills, while clearly defined by respondents, largely fall outside traditional occupational classifications. Most are specific to real-world energy systems and process environments, suggesting that the formal skill frameworks currently in use are too narrow to reflect the interdisciplinary and applied nature of actual labour market needs.

This analysis highlights a dual challenge: organisations must not only recruit for these emerging roles but also ensure access to training that develops integrated technical and transversal skills in parallel.

Future Competencies (Q14)

Survey participants were asked to identify the key competencies they believe will be critical to the success of their organisations over the next two to five years. The responses provide a detailed snapshot of how employers are thinking about the evolution of workforce requirements in the renewable energy sector.

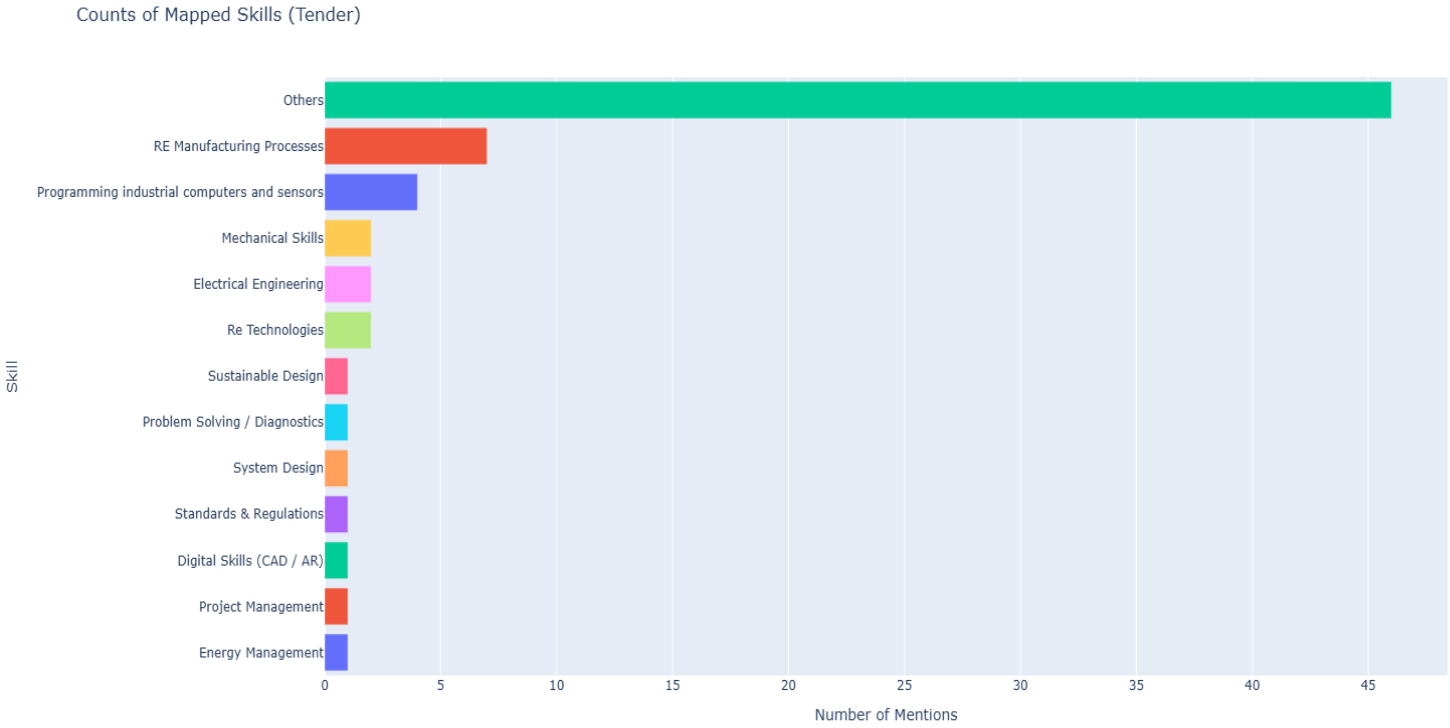
The most frequently mentioned competency was related to **manufacturing processes for renewable energy technologies**. This emphasis reflects a growing need for workers capable of engaging with the technical realities of scaling up green infrastructure, particularly in relation to process integration, component assembly, and systems optimisation.

A second cluster of competencies relates to the **programming of industrial systems**, including the use of embedded sensors and automated control technologies. The recurrence of these skills signals a convergence between traditional industrial engineering and emerging digital capabilities. Respondents anticipate that future workers will need to navigate both physical and digital environments in real time, particularly in production, maintenance, and diagnostics.

Beyond these technical proficiencies, respondents also pointed to a broad set of forward-looking, yet less formally recognised, competencies. These include **strategic planning, innovation management, sustainable design, fluid dynamics,** and **leadership in digital transformation**. Except for **fluid dynamics**, a more specialised and technical skill, the common thread across these responses is a growing demand for **systems thinking**, individuals capable of understanding how technologies, regulations, supply chains, and human behaviour interact within a dynamic energy ecosystem.

The diversity of these future competencies suggests that employers are no longer prioritising narrow technical expertise alone. Instead, they are seeking professionals who can combine domain-specific knowledge with adaptive,

interdisciplinary, and strategic capabilities. This shift underscores the importance of rethinking education and training systems to better align with the real and rapidly evolving skill demands of the clean energy transition.



Transferable Skills from Other Sectors (Q15)

In assessing which external sectors could supply transferable skills to the renewable energy workforce, respondents pointed to a wide range of industries. The most frequently cited were information technology (16 mentions), manufacturing (11), digital services (7), energy (7), and semiconductors (7), followed by electrical, mechanical, construction, R&D, and mining sectors.

In the first tier of analysis, a limited number of skills were identified as already matching those listed in the project tender. These matched skills include:

- *Electrical Engineering*
- *System Design*
- *Project Management*
- *RE Manufacturing Processes*
- *Programming Industrial Computers and Sensors*
- *Digital Skills (CAD / AR)*
- *Sustainable Design*
- *Standards & Regulations*

These matched skills were distributed primarily across IT, manufacturing, digital, and electrical sectors, reflecting the continuity between core technical occupations and the energy transition.

Figure 8: 2023 Survey: Answers to question 15.

However, some of entries did not match the project's classification and were grouped under "Others" in the original matching. These not matched skills include:

- *manage standard enterprise resource planning system*
- *handle external financing*, *manage government funding*, *establish investment funds*
- *recruit employees*, *support managers*, *manage sales teams*

These results show that employers are drawing not only on technical proficiencies, but also on a wide array of process, management, and soft skills acquired in neighbouring sectors. Experience in manufacturing, for example, is valued not only for production capabilities but also for understanding automation, compliance, and industrial planning. IT backgrounds bring crucial experience with diagnostics, simulation, and integration of smart technologies into renewable energy systems.

The findings underscore that a share of relevant competencies currently in use are not yet captured by institutional frameworks. Many of these skills are transversal, spanning technologies, sectors, and value chains, and are especially useful in both re-skilling initiatives and foundational training programmes. This versatility supports smoother career transitions for professionals entering the energy sector from adjacent industries and highlights the need to modernise recognition systems and training pathways to reflect this evolving reality.

3.1.5. Qualitative Findings

Across the survey responses, several qualitative themes emerge that complement and contextualise the quantitative findings.

Recruitment Challenges (Q6 & Q7):

A recurring difficulty cited by organisations is the shortage of qualified candidates for core technical roles, particularly engineers, technicians, electricians, and operational managers. These challenges are sector-specific: geothermal organisations reported a lack of reservoir and drilling engineers; solar PV companies pointed to gaps in manufacturing and scale-up experience; and offshore wind stakeholders struggled to recruit for high-voltage engineers, marine specialists, and legal or consenting experts. Additionally, research institutions and academia reported difficulty attracting researchers and technical support staff, citing a lack of applications, insufficient experience, or educational mismatch.

Internal Training (Q9):

Most organisations provide internal training, though its form and duration vary widely, from structured, multi-month modules (e.g., Ganz) to short induction sessions or ad hoc training. Hands-on learning and internal courses are common, but formal collaboration with universities or external providers remains limited. A minority outsource or combine training delivery. In some cases, companies such as Biogas sector actors indicated the creation of internal "academies" to bridge persistent training gaps.

Training Priorities (Q10):

The groups most often identified as needing training were engineers, technicians, operators, and research scientists. Engineering and technician training needs were noted across nearly all sectors, while operator upskilling was a priority in the biogas and electrical equipment manufacturing sectors. Researchers and scientists were identified in academia and PV manufacturing as needing support for interdisciplinary and innovation-oriented tasks.

Sector Growth Drivers (Q13):
Respondents identified a variety of anticipated growth factors for their sectors. These include regulatory drivers (e.g., Guarantees of Origin and digestate frameworks in biogas), industrial policy and reshoring (e.g., EU value chain investments in solar), technology innovation (e.g., floating wind and hybrid systems), and the increasing digitalisation of production processes (e.g., at Ormazabal). Many stakeholders cited ongoing infrastructure investments and energy transition targets as key demand accelerators.

Policy Recommendations (Q16):

Suggestions for addressing the skills gap were remarkably consistent across technologies. Respondents called for greater inclusion of renewable energy skills in formal education curricula, especially vocational and dual-training systems. Apprenticeships, university collaboration, and practical placements were also proposed. Some stakeholders emphasised the need for EU-wide qualification frameworks and better recognition of international experience, particularly to ease labour mobility. WindEurope and others also flagged the importance of gender mainstreaming and broader diversity strategies to widen the recruitment base.

3.2. 2025 Statistical Report on Skills Needs in the Renewable Energy Sector

3.2.1. Objectives

This report presents the results of the 2025 survey on occupational profiles and skill gaps in the renewable energy sector. It was designed to complement the 2023 dataset by collecting updated information from labour market actors and identifying recent shifts in job demands, skill requirements, and recruitment difficulties. The data

provides a more current and detailed understanding of sectoral workforce needs as of early 2025.

3.2.1. Respondent Overview and Sectoral Representation

The **34 respondents** to the 2025 survey represented a mix of **14 countries** and different organisational backgrounds. Countries included Germany (9), Spain (3), Belgium (3), Turkey (3), Italy (2), Finland (2), Austria (2), Romania (2), United Kingdom (1), Sweden (1), Norway (1), Netherlands (1), France (1), Portugal (1), and the United States (1). Organisation types spanned small and medium-sized enterprises (7), research centres (7), trade associations (7), non-profit organisations (4), large corporations (4), educational institutions (3), and individual responses from a regulatory authority and a regional transmission organisation.

Primary sectors represented included solar energy (16 mentions), renewable gases such as hydrogen and biogas (13), energy storage technologies (10), heat pumps (10), battery systems (10), bioenergy/biomass (9), photovoltaic and solar thermal systems (9 each), wind energy (9), and geothermal (4). One respondent also covered the electrical grid. While the professional experience levels ranged from under three years to over a decade, with most participants (21 out of 34) reporting more than 10 years of experience in the renewable energy field.

Figure 9: Number of organisations by country

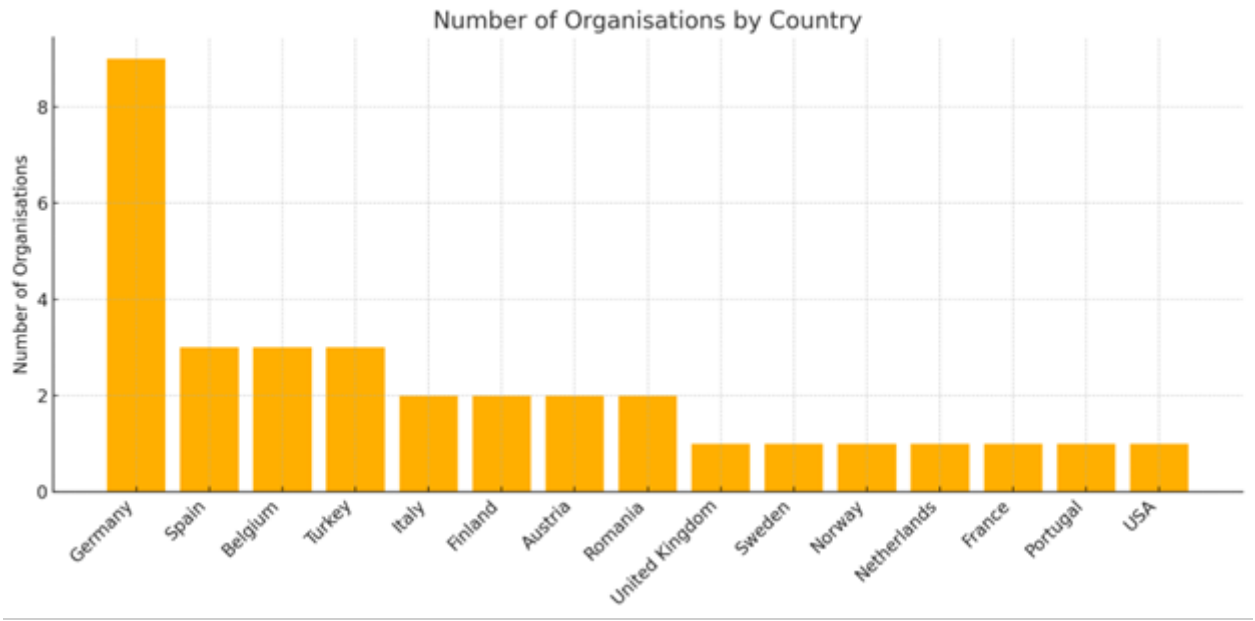


Figure 10: Number of organisations by organisation type

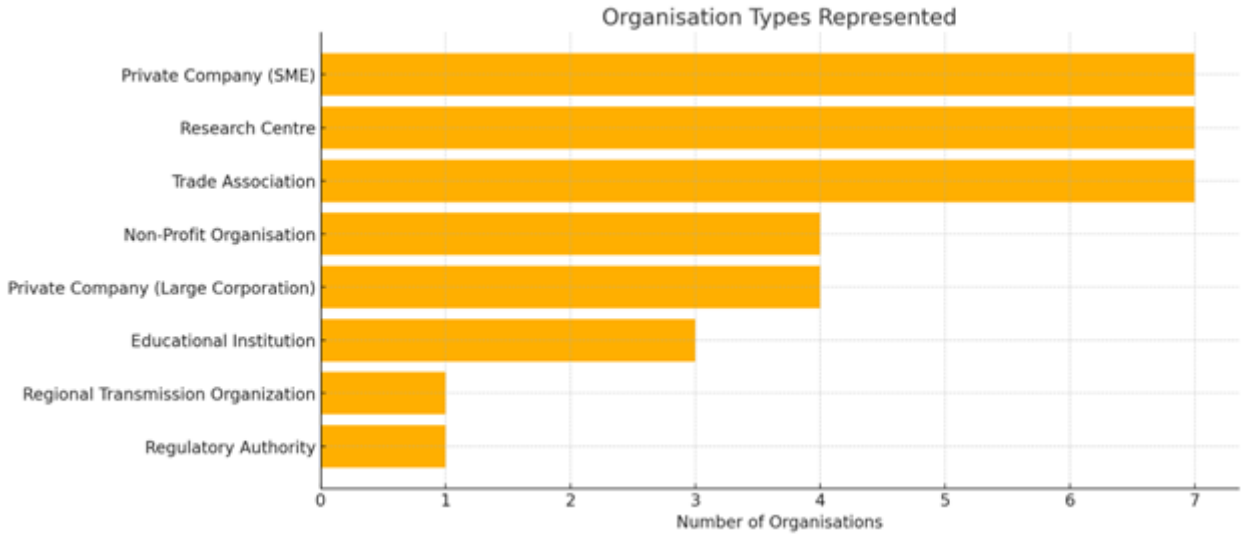
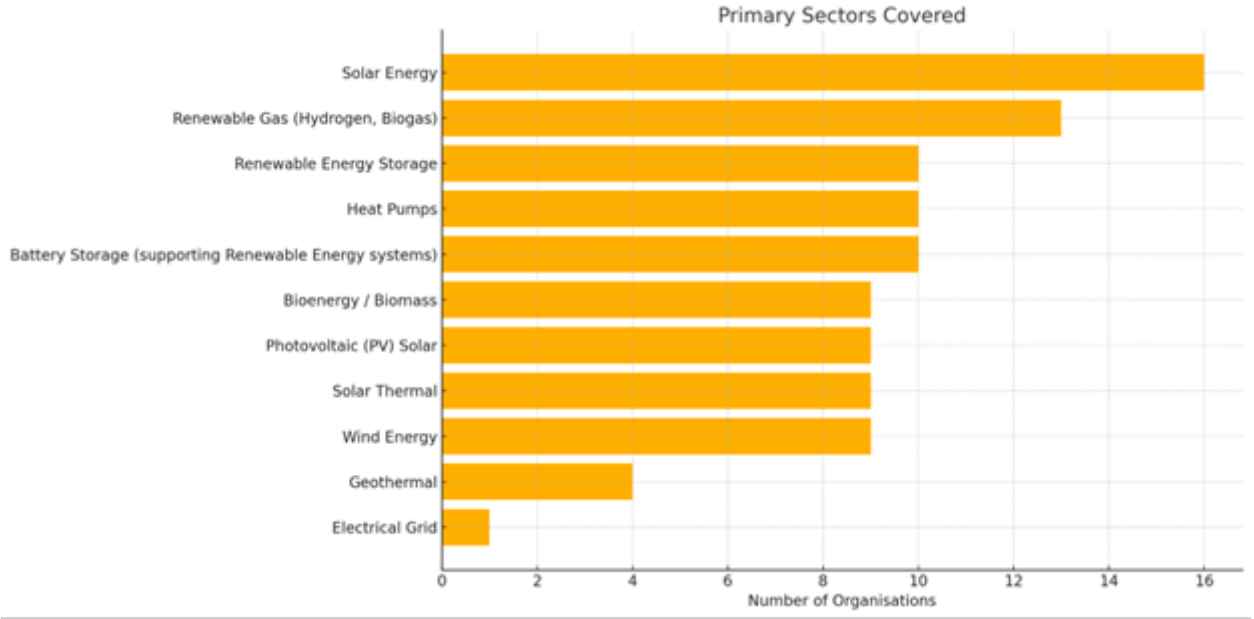


Figure 11: Number of organisations by primary sector covered



Hiring Difficulty

Survey responses reveal that the most difficult roles to hire within the energy transition workforce are highly technical and specialised. Among the hardest to fill are ***Renewable Energy Technicians (Wind, Solar), Gas Technicians (Biogas, Hydrogen)***, and ***Critical Raw Material Recovery Specialists***. These roles are critical for system installation, operation, and end-of-life management. The difficulty in sourcing such talent highlights a shortage of vocational training and certification pathways tailored to these domains. Additionally, across key skill categories, including design, production, installation, operation, and circularity, respondents consistently reported shortages in technically demanding roles. For instance, ***System Design (Digital), Manufacturing Processes, Electrical Engineering***, and ***Safety Protocols*** in O&M are repeatedly marked as "hard to find." This suggests a systemic talent gap in the technical implementation and oversight of renewable energy projects. To close this gap, targeted workforce development programs, reskilling of adjacent professions, and expanded apprenticeship models will be essential.

3.3 Current and Future Demand

Across all categories, roles and skills tied to engineering, installation, and system integration are seen as both currently in demand and expected to remain so in the near future. The most frequently cited roles include *Energy Engineers* and *Renewable Energy Technicians*, reflecting the foundational importance of both system design and physical implementation. On the skills side, demand is high for *Modelling and Simulation*, *Mechanical Skills*, *System Installation*, and *Energy Management*, among others. These are required throughout the lifecycle of renewable energy infrastructure, from conceptual design to long-term operation. Notably, installation and O&M skills such as *System Design and Sizing*, *Diagnostic Tools*, and *Regulatory Knowledge* also feature prominently in future demand expectations, highlighting the need for a workforce that can manage increasingly complex and decentralised energy systems. In addition, the growing emphasis on *Life Cycle Assessments* and *Circularity Standards* indicates that end-of-life management is becoming a strategic concern for the sector, further diversifying the range of high-priority skill areas.

Additional Roles (Open Responses)

Participants were asked to list additional occupational profiles beyond the predefined categories. Some of these still correspond to broader occupational profiles in the initial list, while new ones were identified as relevant for present and future labour needs.

- Heat Pump Installer
- Quality Manager
- Electrochemist / Battery Sales Expert
- Energy Researcher
- Energy Manager / Consultant
- Governmental Energy Administrator
- Certification Expert / Expert in Technical Regulation Implementation
- Sustainability Expert
- Curriculum Designer / Technical Educator
- SCADA Programmer
- Project Manager for RE Projects
- Grid Integration Engineer
- Multi-Energy Systems Specialist
- Specialised Technical Engineer
- Sales and Marketing Professional
- Training and Education Professional
- Researcher

A recurrent observation was the excessive specialisation of current profiles, particularly in consultancy, energy management, and public administration, often restricted to a single energy carrier or technology. This narrow scope, shaped by rigid educational pathways, can lead to misaligned or suboptimal solutions in decarbonisation strategies. Respondents highlighted the urgent need for professionals trained in cross-carrier energy systems and capable of delivering flexible, system-wide strategies across both technical and deployment contexts.

Additional Skills (Open Responses)

Participants also listed missing or emerging skills essential for workforce development. Many of these still correspond to broader skills in the initial list. These include:

- Process engineering

- Application of artificial intelligence
- Knowledge of legal and regulatory requirements
- Skills in digitalisation and automation
- Cross-carrier energy system planning
- Implementation of technical regulations
- Sustainability compliance
- Grid integration and project coordination
- Use of electronics and automation in renewable energy systems

The emphasis across responses was clear: the future renewable energy workforce must combine engineering competence with regulatory fluency, digital system literacy, and strategic integration of multi-energy technologies.

3.4. Conclusion

Insights from the 2023 and 2025 Workforce Surveys

Taken together, the 2023 and 2025 surveys present a comprehensive and evolving portrait of the renewable energy sector's workforce landscape, one that is marked by consistent challenges, emerging role transformations, and an increasingly urgent need for systemic adaptation. While each survey reflects the conditions of its respective moment, a strong continuity emerges in the trends they capture: a sector growing in technical complexity, diversifying in role requirements, and straining against the limits of existing training and qualification frameworks.

A persistent theme across both years is the **critical shortage of technical professionals**, particularly in roles such as **Renewable Energy Technicians, Gas Technicians,** and **Energy Engineers**. These are not peripheral positions; they are foundational to project execution, system reliability, and lifecycle management. Their continued scarcity from 2023 to 2025 underscores a systemic disconnect between labour supply and the sector's operational needs. Even as awareness of these gaps grows, education and certification systems appear too slow to adjust, leaving key roles underfilled and projects at risk.

Equally significant is the **rise of new, hybrid, and interdisciplinary job profiles**. In 2023, the emergence of roles like **Software Developers, Mechatronics Engineers,** and **Digital Modelling Experts** highlighted a shift toward the integration of physical and digital systems. By 2025, this evolution had accelerated, with open-ended responses identifying demand for S**CADA Programmers, AI specialists, Sustainability Experts**, and **Cross-Carrier Energy System Planners**. These newer roles reflect a workforce increasingly expected to operate at the intersection of energy engineering, data analysis, automation, and regulatory compliance.

Both surveys also point to a deepening emphasis on **systems thinking** and **interdisciplinary fluency**. Employers are no longer looking for narrowly trained specialists but rather for professionals who can understand entire value chains, designing, operating, and optimising systems that are distributed, digitised, and regulatory-bound. Skills such as **Modelling and Simulation, System Design and Sizing,** and **Life Cycle Assessment** are consistently prioritised. Meanwhile, gaps persist in areas like automation control, regulatory knowledge, and digital integration, which are essential to scaling smart infrastructure across technologies and jurisdictions.

The data also reveals an increasing reliance on **transferable skills from adjacent sectors**. In 2023, industries such as IT, manufacturing, and digital services were recognised as important sources of relevant talent, especially in areas like project management, automation, and software integration. By 2025, this trend had deepened, with respondents explicitly calling for smoother transitions from these sectors into clean energy roles. However, they also noted **institutional barriers**: rigid qualification standards, lack of recognition for applied skills, and the over-specialisation of training programs that limit cross-sector mobility.

Finally, both years highlight a troubling **misalignment between formal training systems and real-world workforce needs**. Respondents repeatedly cite the absence of adaptable, modular training pathways, the slow reform of curricula, and the lack of collaborative frameworks between education providers and industry. While some

companies have created internal “academies” or short-format upskilling programs, these are fragmented efforts, insufficient to address the scale of the transition ahead.

In sum, the surveys present a clear and urgent call to action: Europe’s renewable energy transition will succeed only if its workforce strategies are as ambitious and adaptive as its technology goals. That means updating qualification frameworks, embedding interdisciplinary learning across all levels of education, facilitating labour mobility across sectors, and aligning public funding with emerging skill demands. The workforce of the future must be technically grounded, digitally fluent, and strategically agile, capable of not only deploying renewable systems, but also designing and governing them in an integrated, sustainable, and resilient way.

4. Job Boards

4.1. Methodology

To assess real-time labour market demand in the renewable energy sector, over 70,000 job postings collected across Europe between February and March 2025 were processed using an automated data extraction pipeline. The pipeline applied natural language processing (NLP) techniques to extract structured information from unstructured vacancy descriptions, identifying both occupational profiles and associated skills. To ensure relevance to the renewable energy domain, the dataset was filtered using a shared list of keywords and sector-specific parameters agreed upon by the ReSkill4NetZero consortium. After filtering and cleaning, a total of 42,073 job postings were retained for analysis.

To enable consistency and comparability across national contexts, a process of structural normalisation was applied. Job postings were aligned with a harmonised taxonomy covering industry sectors, occupational categories, and skill types. Skills were then classified as either hard (technical) or soft (human) competencies. The full content of each job description was reviewed to ensure that the matching process reflected the actual requirements of the role, rather than relying solely on job titles.

For skill extraction, large language models (LLMs) were employed to perform entity recognition within job descriptions. Extracted skills were then matched to the ESCO taxonomy to ensure terminological standardisation and improve interpretability across datasets. In addition, for specific analyses related to project deliverables, the extracted skills were also matched to the set of skills defined in the grant agreement, allowing alignment with the project's internal framework. However, throughout the report, references to skill data primarily rely on ESCO terminology for consistency and comparability.

Occupational profiles, by contrast, were matched not to ESCO but to the 13 predefined occupational profiles outlined in the grant agreement. These matching were informed not only by job titles but also by the broader context and responsibilities described in each posting, allowing for a consistent interpretation even when terminology varied.

Together, these steps ensured that the resulting dataset provided a reliable and structured representation of labour market demand in the renewable energy sector, grounded in methodological rigour and contextual relevance.

4.2. In-Demand Occupational Profiles

This section presents an integrated analysis of the most in-demand occupational profiles identified through job board data. It includes both roles that could be successfully matched to the 13 initial profiles defined in the grant agreement and others that, despite being frequently advertised, fall outside the current framework. Together, they provide a comprehensive view of labour market demand across the renewable energy ecosystem.

The matching exercise revealed clear demand patterns, with certain predefined profiles dominating the job market. **Energy Engineers** appeared in 6,239 job advertisements, followed by **Industrial Engineers** (5,382) and **Renewable Energy Technicians** (4,508). Among blue-collar roles, **Factory Operatives / Maintenance** and **Industrial Electricians** were also prominent, with 3,124 and 2,886 job ads respectively. These results confirm the strong demand for technical, engineering, and operational roles that underpin Europe's energy transition efforts.

Other profiles, such as **Renewable Energy Consultants (**2,548 job advertisements**), Health and Safety Professionals** (1,761 job advertisements), and **Planners** (1,200 job advertisements), were also well represented, suggesting a steady need for roles involved in project development, regulatory compliance, and spatial integration. In contrast, roles like **Electricians (Domestic)** (198 job advertisements)**, Gas Technicians** (63 job advertisements)**,** and **Critical Raw Material Recovery Specialists** (only 2 job advertisements) appeared far less frequently. Their limited visibility may reflect their niche character, self-employment structures, or the use of alternative recruitment pathways, such as word-of-mouth or apprenticeships, not captured by public job board data. Regarding the electricians, for instance,

a 2024 survey by German electrical contracting associations found that companies would collectively hire 96,000 additional workers if qualified professionals were available, highlighting that unmet demand may be significantly higher than job ads suggest.

However, the analysis also revealed important coverage gaps between job market trends and the predefined occupational profile list. While many of the top 20 advertised job titles were successfully matched to one of the 13 initial profiles, a significant number were either only partially matched or not matched at all. For example:

- **Electrical Engineer**, the most advertised role with 2,561 postings, was spread across multiple matched profiles (Energy Engineers, Industrial Engineers, Industrial Electricians, among others), yet a substantial share of postings did not fully align with any one profile.

- **Software Developer, Project Manager, Senior Cloud and AI Architect, Quality Assurance Engineer, Senior Software Architect** and **Quality Control Technician** were more frequently matched with none of the initial job roles than to one matched job role. Indicating they encompass a broader responsibility that the current framework does not fully capture

These findings suggest that several digital, leadership, and quality-oriented roles, many of which appear instrumental in the development and scaling of clean energy infrastructure, are not yet fully reflected in the project's occupational profile framework. While further analysis may be needed, their frequency and functional relevance point to evolving workforce demands that could warrant broader recognition within the occupational taxonomy.

Table 3: Roles matched to the initial 13 Occupational Profiles

Value Chain Role	Total count
Energy Engineers - white collar professionals	6239
Industrial Engineers - white collar professionals	5382
Renewable Energy Technicians (wind/solar/geothermal/heat pumps)	4508
Factory operatives/Maintenance - blue collar professionals	3124
Industrial Electricians - grey collar professionals	2886
Planners - white collar professionals	1200
Renewable Energy Consultants - white collar professionals	2548
Health and Safety Professionals - grey collar professionals	1761
HVAC and Refrigeration Technicians	1029
RE Power Plant Operators - grey collar professionals	368
Electricians (Domestic) - grey collar professionals	198
Gas Technicians (biogas/hydrogen)	63
Critical Raw Material Recovery Specialists	2

Table 4: Top 20 Roles

Job Title	Count
Electrical Engineer	2561
Field Service Technician	1131
Project Manager	724
Software Developer	686
Automation Engineer	551
Process Engineer	402
Senior Capacity Engineer	322
HVAC Maintenance Engineer	309
Quality Engineer	306
Senior Software Architect	289
Senior Cloud and AI Architect	280
HVAC Maintenance Technician	278
Machine Operator	278
Electrical Draughtsperson	274
Electrotechnical Maintenance Technician	267
Quality Assurance Engineer	260
Wind Turbine Technician	247
Operations Manager	241
Quality Control Technician	240

4.3. Breakdown of Job Titles by Occupational Profile

To gain a more detailed understanding of the labour market demand within each occupational profile, job titles were analysed at a granular level. This revealed both the functional diversity within each profile and the variations in terminology used by employers across countries and sub-sectors.

Within the **Energy Engineers** category, some of the frequently advertised role was Electrical Engineer, Project Manager, Software Developer, Senior Capacity Engineer, and Senior Software Architect. Which reflects the broad applicability of energy engineering expertise, encompassing both traditional electrical systems and increasingly digital or software-driven domains. The presence of roles such as Software Developer and Project Manager may seem unexpected in this category at first glance; however, the content of these job postings, including responsibilities

related to energy systems design, integration, modelling, and digital control, aligned closely with the role definition for Energy Engineers as outlined in the project. This highlights how digitalisation, systems leadership, and cross-functional coordination are becoming core components of engineering functions in the renewable energy sector.

For **Industrial Engineers**, the job titles indicated a strong focus on process optimisation and automation, since Process Engineer, Automation Engineer, and Quality Engineer appear as frequent job titles. Additional roles such as Project Manager and Electrical Engineer were also present, reinforcing the interdisciplinary overlap between industrial engineering, energy systems, and technical project coordination. Notably, the presence of *Electrical Engineer* within both this and the *Energy Engineers* category illustrates that the alignment of roles with occupational profiles often depends more on the context and content of the job posting than on the title alone. In this case, this happened because the role descriptions focused on production systems, automation, and manufacturing process design, core aspects of the *Industrial Engineer* profile as defined in the project. This underscores how the initial occupational profiles can accommodate a range of functionally similar roles, with distinctions that are more contextual than semantic.

In general, the roles captured for the **Renewable Energy Technicians** profile are linked to field-level execution and systems maintenance. Some of those roles are: Field Service Technician, Wind Turbine Technician, Maintenance Technician, and Photovoltaic Installer. This profile clearly reflects the hands-on operational layer of renewable energy deployment.

In the **Factory Operatives / Maintenance** category, job postings were largely focused on production line and maintenance roles. Roles such as Maintenance Technician and Machine Operator were very frequent, together with Field Service Technician, CNC Machine Operator, and Production Operator. These findings are consistent with the growing demand in areas like battery assembly, solar module production, and other clean tech manufacturing processes.

For **Industrial Electricians**, some of the common titles were Electrical Technician, Electrical Draughtsperson and Electrotechnical Maintenance Technician. While the **Renewable Energy Consultants** profile included specialised, advisory-oriented roles such as Renewable Energy Coordinator, Sustainability Consultant, Renewable Energy Engineer, Electrical Engineer, and Energy Utilities Consultant. These postings reflect a mix of technical and strategic competencies required in areas like energy planning, regulatory compliance, and project development. The inclusion of *Electrical Engineer* among these roles illustrates the broad versatility of electrical expertise, which is not limited to hands-on technical execution but also extends to consultative and system-level advisory roles. This reinforces the relevance of engineering knowledge in both operational and policy-influencing functions within the renewable energy transition.

In the **Health and Safety Professionals** category, some of the most consistent job titles were Health and Safety Manager, HSE Specialist, Environmental Health & Safety Manager, Health and Safety Specialist and Health and Safety Officer. This uniformity likely reflects the influence of regulatory frameworks governing occupational health and safety across the EU and national contexts. Given that many renewable energy projects involve construction, heavy machinery, or hazardous materials, employers are required to comply with stringent safety regulations, such as the EU Occupational Safety and Health Framework Directive, which mandates the presence of certified OHS professionals with clearly defined responsibilities. As a result, job titles in this domain tend to follow a standardised nomenclature, ensuring alignment with formal compliance requirements and recognised professional qualifications.

Under the **Planners** profile, the most frequent job titles reflected both project-level and sustainability-focused planning. Project Manager, Sustainability Manager, Electrical Engineer, Environmental Manager, and Sustainability Consultant were common roles. This mix indicates that planning functions often intersect with environmental strategy, permitting processes, and infrastructure integration.

HVAC and Refrigeration Technicians were represented through roles like HVAC Maintenance Engineer, HVAC Maintenance Technician, Maintenance Technician, HVAC Technical Designer, and HVAC Designer, confirming the specialised and evolving role of climate control systems in energy efficiency and building retrofits.

For **RE Power Plant Operators**, the common roles included Chemical Plant Operator, Machine Operator, and Wind Turbine Electrician. These reflect the broad responsibilities associated with renewable energy production facilities. As for the **Electricians (Domestic),** were advertised more frequently under technical titles, such as Electrical Draughtsperson, Electrical Designer and Electrical Installer. For **Gas Technicians (Biogas / Hydrogen)**, the dataset identified specialised positions such as Gas Network Manager, Hydrogen Vehicle Architectural Engineer, Maintenance Technician, and Field Service Technician, reflecting the nascent but growing demand for technical roles in hydrogen and biogas infrastructure.

Finally, under **Critical Raw Material Recovery Specialists**, only two relevant job postings were identified across the entire dataset. Given the extremely low volume, this data point is not statistically significant and does not allow for meaningful conclusions. It is likely that roles in this area are either too niche to appear frequently in public job boards or are primarily concentrated in contexts that use alternative recruitment channels.

Occupational Profiles by Country

The country-level distribution of job postings reveals clear patterns of labour demand in the renewable energy sector across 26 out of 27 EU member states. The reason there's one less is that Malta didn't return any job postings. While some roles appear consistently across nearly all national contexts, others reflect more concentrated or specialised regional needs.

Electrical Engineer stands out as the most ubiquitous role, with 2,561 job postings spanning 25 out of 26 countries (all except Czechia). This highlights the essential nature of electrical expertise across renewable energy systems, from infrastructure design to power electronics and grid integration. Similarly, **Field Service Technician** (1131 postings) and **Maintenance Technician** (724 postings) were also widely advertised, present in nearly all countries, the first one is only not present in Czechia, and the second one is neither present in Czechia or Latvia. These roles reflect the growing importance of hands-on operations and maintenance (O&M) capacity in mature and emerging renewable markets.

Other broadly distributed roles include:

- **Project Manager**, 686 postings, present in 24 countries (except Czechia and Estonia), pointing to the need for strong coordination and implementation capabilities in large-scale energy projects.

- **Software Developer**, 571 postings, found in 25 countries (except Czechia), demonstrating the critical role of digitalisation, smart control systems, and software integration in renewable energy deployment.

- **Automation Engineer**, 551 postings, advertised in 25 countries (except Czechia), indicating strong demand for professionals supporting process control, SCADA systems, and industrial automation.

While most high-demand renewable energy job roles appeared across nearly all 26 countries analysed, a few showed slightly more limited geographic spread, offering insight into subtle differences in regional industrial activity, infrastructure maturity, or workforce development needs.

Two roles stand out as the least geographically distributed among the top job titles:

- **Electrical Draughtsperson**, with 274 postings, was absent in six countries: Bulgaria, Czechia, Estonia, Latvia, Lithuania, Slovakia
- **Wind Turbine Technician**, with 247 postings, also did not appear in six countries: Austria, Czechia, Latvia, Lithuania, Slovakia, Slovenia

Despite this narrower spread, the role was still present in 20 countries, indicating broad relevance across Europe. However, its absence in countries such as Austria, which has a well-established wind sector with over 4 GW of

installed capacity and ongoing repowering projects, suggests that factors other than market maturity may be at play. These could include alternative recruitment methods and differences in job posting platforms

Other roles with slightly narrower distribution include:

- **Process Engineer** (402 postings), not advertised in 5 countries: Cyprus, Czechia, Estonia, Latvia, and Lithuania.
- **HVAC Maintenance Engineer** (309 postings), also absent in 5 countries: Cyprus, Czechia, Estonia, Latvia, and Slovenia.
- **Machine Operator** (278 postings), not seen in: Cyprus, Czechia, Estonia, Finland, and Slovenia.

While the absolute number of countries where these roles are missing is small, it still points to regional variations in industrial readiness and clean tech deployment. The absence of HVAC and process-related roles in countries like Cyprus, Estonia, or Latvia, for instance, could reflect differences in building retrofit policies, local manufacturing ecosystems, or the pace of decarbonisation in heavy industry.

Even among widely demanded roles, subtle gaps in country-level presence can reveal where specific occupational needs have not yet emerged, or where labour demand may be met through other channels. While these roles are not nationally confined, their relative absence from a small cluster of countries could signal opportunities for targeted upskilling, infrastructure investment, or policy activation to stimulate demand in those areas. As such, they are not exceptions, but useful indicators of where to direct effort to ensure even workforce readiness across Europe.

4.4. Skills Associated with Key Job Titles

To complement the occupational profile findings, the most frequently requested skills were extracted from the top job postings associated with renewable energy roles. This analysis offers a detailed view of the technical and cross-functional capabilities most commonly sought by employers and evaluates how well these align with the pre-identified skills list proposed in the grant agreement.

Across the dataset, several patterns stood out. **Data analysis** was one of the most frequently requested skills, appearing prominently in roles such as *Automation Engineer*, *Project Manager*, *Electrical Engineer*, *Quality Engineer*, and *Software Developer*. While this skill could fall under the broader "Digital Skills (CAD/AR)" category from the initial list, its high frequency and broad applicability suggest it can be treated as a distinct subcategory.

Programming and automation skills were also highly visible, especially in digital and control system roles such as *Automation Engineer*, *Senior Software Architect*, and *Cloud & AI Architect*. Skills like *apply basic programming skills* and *Python (computer programming)* were typically matched to "Programming industrial computers and sensors" from the grant-defined list. This reflects some level of alignment and demonstrates the need to surface more granular digital competencies explicitly.

Electrical engineering appeared as a recurring skill across a wide range of roles, including *Field Service Technicians*, *Maintenance Technicians*, and *Electrotechnical Maintenance Technicians*. This confirms that electrical knowledge is foundational to the sector and well captured in the initial framework through skills such as *Install electrical systems* and *Maintain electrical systems*.

Project-focused and coordination-heavy roles, such as *Project Manager*, *Operations Manager*, and *Process Engineer*, consistently required ***project management, team leadership,*** and ***stakeholder communication***. These were largely matched to *Manage energy projects*, *Lead a team*, and similar entries in the grant list. However, other frequently requested capabilities, such as *encourage team building* and *create solutions to problems*, remained unmatched and should be explicitly recognised in the list of high-demand transversal competencies.

Trade and operations roles, like *HVAC Technicians*, *Machine Operators*, and *Maintenance Technicians*, featured practical, hands-on skills such as ***maintain equipment, oversee quality control, troubleshoot,*** and ***maintain air***

conditioning systems. These were well aligned with skills like *Maintain heating systems*, *Perform scheduled maintenance*, and *Apply safety procedures in energy systems*, demonstrating that operational skill needs are generally well addressed in the initial selection.

Finally, it's important to note that while this section focused on the top skills by role, an analysis of the overall skill frequency across all job postings revealed very similar trends. The highest-ranking skills, including ***perform data analysis***, ***project management***, and ***electrical engineering-related tasks***, remained consistently dominant, reinforcing the findings of the role-specific breakdown. This consistency suggests that the most in-demand skills are not confined to a single role or job category, but instead reflect core competencies required across the renewable energy workforce.

4.5. Conclusion and Recommendations

The job board analysis has offered a robust and timely overview of real-world labour market demand in the renewable energy sector, based on more than 42,000 job postings collected across 26 European countries. This dataset, filtered for renewable energy relevance and processed through natural language analysis and structured matching techniques, allowed for the systematic extraction of occupational profiles and associated skills. The results confirm that many of the initial profiles and skills defined in the grant agreement remain highly relevant, but also point to important gaps and areas for improvement.

Occupational Profiles

The predefined occupational profiles captured a large share of demand, with profiles like Energy Engineers, Industrial Engineers, Renewable Energy Technicians, Factory Operatives / Maintenance, and Industrial Electricians collectively accounting for tens of thousands of job postings. This confirms the foundational importance of engineering, operations, and technical implementation capacity across the energy transition.

However, the data also revealed that several of the most frequently advertised job titles, including Electrical Engineer, Project Manager, and Software Developer, were only partially matched to the initial profiles. These roles often straddled multiple categories or exceeded the boundaries of the existing definitions. More critically, several high-frequency roles, such as Senior Software Architect, Senior Cloud and AI Architect, Quality Assurance Engineer, Operations Manager, and Quality Control Technician, were not matched at all, despite appearing in hundreds of postings.

These matched roles are not marginal. They represent essential functions tied to digital system design, AI integration, platform development, operational leadership, and quality assurance, all of which are becoming increasingly central to the deployment, scaling, and reliability of renewable energy infrastructure.

Recommendation – Occupational Profiles:

- Maintain the 13 existing profiles as a validated core set, but expand the framework to reflect observed labour market demand.
- Add new occupational profiles to capture frequently advertised but unmatched roles, particularly:
    - Software Developers and Architects
    - Cloud and AI Systems Specialists
    - Quality Assurance / Quality Control Professionals
    - Operations and Delivery Managers
- Consider introducing functional sub-categories within existing profiles (e.g. *Digital Energy Engineers*, *Renewable Software Architects*) to preserve structural clarity while improving coverage.
- Include alternative job titles under each occupational profile (e.g. Energy Engineer, Renewable Energy

Engineer, Power Systems Engineer) to better capture overlapping roles and improve alignment with employer terminology.
- Ensure that future matchings are based not only on job titles but on the actual responsibilities described, as role boundaries are increasingly fluid and cross-disciplinary.

Skills

The skill analysis revealed strong alignment between many job postings and the initial grant-defined list. Core technical skills such as Project Management, Electrical Engineering, System Design, and Operation & Maintenance were repeatedly confirmed across a wide range of roles.

However, the analysis also highlighted key competencies that are critical in practice and may warrant clearer distinction within the initial framework. While skills such as data analysis, basic programming, and Python fall under the broader category of digital skills already included in the initial list, their frequency and functional relevance suggest they could be more explicitly represented. Similarly, soft skills related to team leadership, stakeholder communication, and coordination were also prominent across roles.

Several of these unmatched skills appeared across multiple roles and sectors, demonstrating their cross-cutting relevance in a digitalising and system-integrated energy landscape.

Recommendation – Skills:

- Include clearer representation or subcategorisation within existing skills categories, such as:
  - Perform data analysis (under Digital Skills)
  - Apply basic programming skills / Python (under Digital Skills)
  - Problem-solving with digital tools (under Digital Skills or Problem Solving)
  - Communicate with stakeholders (under Soft Skills)
  - Lead a team / Encourage teambuilding (under Leadership or Soft Skills)
  - Apply safety procedures in laboratory (under RE Safety Protocols and permits)
- Strengthen the representation of soft and managerial competencies, especially those tied to project delivery, coordination, and leadership.
- Maintain strong coverage of hands-on technical skills, which remain essential in technician and operational roles.

5. Interviews: Skills Needs and Gaps Across the Renewable Energy Sector

5.1. Introduction

To complement the quantitative findings from the project's survey, a series of qualitative, semi-structured interviews were conducted with experts across various renewable energy sub-sectors. These interviews aimed to gather in-depth insights on the dynamic skills landscape that cannot be fully captured through survey data alone.

Nine interviews were conducted between April and May 2025, and the data collected from them are represented in this section. Participants were selected for their extensive professional experience and strategic roles in renewable energy fields, including power systems, heating and installation, photovoltaics (PV), energy policy, biomethane and biogas, and HR and talent management.

Each interview followed a semi-structured format guided by four thematic areas:

1. Job roles in demand within the participant's sector.
2. Skills in demand, both hard (technical) and soft (interpersonal and managerial).
3. The role of training and education in addressing existing skills gaps.
4. Future skills needs, considering ongoing technological, regulatory, and economic changes in the sector.

All interviews were conducted remotely and relied on an interview guide that was shared in advance with participants and adjusted to their roles and areas of expertise. Consent forms were sent to participants prior to the interview, providing information about the project and the treatment of the information collected.

This approach allowed for the collection of rich, context-specific insights while maintaining enough structure to enable cross-interview comparison. Responses were analysed thematically to identify recurring challenges, sector-specific needs, and opportunities for policy and education alignment.

Below is a summary of the participants' demographic characteristics:

Table 5: *Participants demographics characteristics*

Participants	Current Role	Sector Focus	Country	Years in Sector
Participant 1 (P1)	Advisor/Expert on Green Skills and Energy systems	Green energy, system-level infrastructure	UK/EU	40+
Participant 2 (P2)	HVAC Company Owner/Manager	Heating, plumbing, renewable energy systems	Austria	20+
Participant 3 (P3)	Senior Advisor at InnoEnergy	Power systems, electrification, batteries	Sweden	40+
Participant 4 (P4)	Thematic Field Leader, Renewable Energies, InnoEnergy	PV, hydrogen, wind, ocean energy	Based in Spain, works EU-wide	20+
Participant 5 (P5)	HR Manager	Biogas and Biomethane	Austria and Wider EU	6 Months
Participant 6 (P6)	Advisor/Expert on skills and talent	HR/Learning and	UK and EU	20+

	management	Development		
Participant 7 (P7)	General Manager	Biogas and Biomethane	Germany/ Worldwide	20+
Participant 8 (P8)	Technical Chief	Photovoltaic	Spain	20+
Participant 9 (P9)	General Director	Photovoltaic	Spain	4

5.2. Job Roles in Need

Across all interviews, critical shortages in job roles were identified, though the nature of the roles varied by sector:

Green Energy Sector: Green energy sector roles are facing acute shortages, particularly in areas like wind and solar energy.

- **Digital security professionals** are increasingly critical, especially considering cybersecurity concerns across energy infrastructure.
- There is a need for **strategic planners and system-level thinkers** in the energy sector.

Heating and Installation: there has been a long-term difficulty in recruiting heating and plumbing technicians in Austria, as P2 states: "After six years of searching, we said, okay, it makes no sense. There is nobody that is suitable for our demands."

- There is high demand for **technical positions** such as those in heat pump installation, though these are often misunderstood or undervalued.
- Roles requiring integration of renewable energy systems (e.g. heat pumps, hybrid systems) are especially hard to fill.
- There is a general reluctance among young people to enter these trades, often due to outdated perceptions of them being “dirty” or low-status jobs.
- The profession is aging, with few younger workers entering to replace those retiring.

Power and Automotive: P3 highlighted a need for experienced managers in startups, noting that "startups and young companies lack mature leadership to guide scale-up efforts." He also pointed to gaps in power electronics and manufacturing.

- **Experienced managerial roles**: Startups and young companies lack mature leadership to guide scale-up efforts.
- **Power electronics specialists**: Crucial for the widespread electrification in renewable energy and automotive sectors.
- **Manufacturing professionals**: There's a critical shortage when transitioning from prototypes to production.
- **Software engineers with systems knowledge**: Needed to bridge the gap between hardware and software in integrated technologies.

PV Manufacturing and Grid: The collapse of the European PV industry in the early 2010s created a vacuum in roles ranging from silicon processing to module assembly. P4 stated, "We are starting from scratch and everything is missing there – blue collars to white collars."

Additionally, P4 flagged a public sector challenge: "They [civil servants] are supposed to process the permitting faster than any time before and they don't know how to do it."

- **Photovoltaic (PV) manufacturing roles** are critically lacking across the entire value chain, from silicon processing to module assembly, due to the collapse of the industry in 2010–2012 and current efforts to rebuild it from scratch.
- **Public sector permitting professionals** are urgently needed to support faster rollout of renewable energy projects, but civil servants often lack the necessary up-to-date skills.
- **Startup companies** in renewables struggle to recruit **C-level roles** (CFOs, COOs, supply chain managers), especially those willing to leave corporate comfort zones for higher-risk ventures.
- **Grid development experts** are also in demand, although this was flagged more as a likely future bottleneck.

Biomethane and Biogas:

- **Plant Operators** and **Maintenance Technicians** are particularly in demand to ensure the smooth operation of biogas plants. According to P7: *"Finding skilled operators who understand the daily workings of a biogas plant is becoming harder and harder. It's a very hands-on job, and not many are trained specifically for this."*

  Process Engineers and **Project Developers** are needed for scaling up new biogas facilities and improving efficiency. According to P7: *"We are seeing a real need for engineers who not only know energy systems broadly, but who understand the specific processes of anaerobic digestion and biogas upgrading."*

  There is growing demand for **Sustainability Consultants** and **Regulatory Compliance Officers**, given stricter environmental regulations and sustainability reporting needs.
- P5 highlighted a need for **site managers**, who require a combination of knowledge and experience within construction and engineering fields, and technical knowledge in the biomethane and biogas sub sectors.
- Another job position in demand and difficult to fill in is within the **Health and Safety** roles, especially in the managerial positions; limitations in terms of filling in both job roles are related to the need for both, site managers and Health and safety managers, to be already living in the countries where the position is needed due to the need for in-depth knowledge of regulations and laws related to both fields, which change from country to country.

Renewable Energy Systems and Energy Efficiency

- **Gas Installers and Maintenance Technicians:** There is strong demand for professionals who can install and maintain gas systems in both residential and industrial settings. According to P8: *"A lot of the troubleshooting is mechanical or electrical, pumps, valves, sensors. If the operator can't fix a simple problem quickly, downtime becomes very expensive."*
- **Renewable Energy Technicians:** A growing need is identified for technicians skilled in installing hybrid systems (solar thermal + gas) and hydrogen-ready boilers.
- **Energy Efficiency Specialists:** Demand is increasing for experts who can integrate energy-efficient technologies into traditional heating systems.

5.3. Skills in Demand

The interviews revealed a broad but overlapping set of skill needs across sectors:

- **Digital and Cybersecurity Skills**:

  - **Digital skills** are the top priority across all sectors of the energy industry, especially in cybersecurity and system infrastructure.
  - **Energy systems knowledge**, including broad system-level understanding, is crucial.
- **Sector-Specific Technical Skills:**
  - **Technical skills** in specific renewable sectors remain in short supply, partly due to public misperception and lack of role awareness.
  - There's growing recognition of the need to **retain and transfer knowledge** from older workers nearing retirement.

P7 has also highlighted need for specific skills within the biogas and biomethane subsector, such as:

  - **Technical operation of biogas plants**: Knowledge of anaerobic digestion, gas upgrading technologies, and waste-to-energy systems.
  - **Maintenance and troubleshooting**: Skills in mechanical, electrical, and hydraulic systems maintenance.
  - **Process optimisation**: Ability to analyse plant data and optimise biogas output.
  - **Environmental monitoring**: Skills related to emissions monitoring and compliance with environmental standards. According to P7: *"New regulations are much stricter about emissions and waste streams, so we need people who can monitor, report, and react in real-time."*

P8 and P9 highlighted the need for specific skills within the Renewable Energy Systems and Energy Efficiency subsector, such as:

- **Installation and Maintenance of Gas and Hybrid Systems**: Expertise in both traditional gas systems and newer hybrid (renewable) systems is crucial.
- **Understanding of New Energy Sources**: Familiarity with hydrogen, biogas, and hybrid systems was repeatedly highlighted.
- **Regulatory Compliance Knowledge**: Technicians need to be well-versed in evolving European and national regulations regarding gas safety and carbon emissions.

- **Multidisciplinary Technical Expertise**:
  - This has especially been highlighted by P3 within the Heating and Installation sub sector. As P3 noted, "A plumber nowadays has to have skills in electrical systems, regulation systems, and all these different types of operational systems."
    - The field also needs better **interoperability understanding**, technicians must ensure multiple systems (e.g., solar, HVAC, heat pumps) work as one.
    - **System-Level and Interdisciplinary Thinking**: P2 emphasised the value of broader thinking: "Software engineers with broader system knowledge are needed to bridge hardware and software domains."
    - **System-level thinking**: P3 highlights this need also among software engineers, to ensure effective integration of new technologies.
    - **Interdisciplinary competence**: Combining engineering, economics, and legal perspectives for robust risk analysis.
- **Leadership, Management, and Policy Awareness:**
  - **Leadership and Financial Skills**: P4 highlighted a recurring challenge in startups: "Most of the time they have all the technical skills, and they are lacking the financial or the supply management skills."
  - **Project management and leadership**: Formal managerial training is urgently needed; learning by doing is not sufficient.
  - **Economic and financial literacy**: Often overlooked but vital for business success in renewables.
  - **Political awareness**: The renewable sector is policy-driven; understanding regulations and political shifts is essential.

- **Soft Skills**: critical thinking, adaptability, and resilience are important but often underemphasised. P2 stressed the importance of independent thinking, lamenting that, "The most important soft skill that

every employee should have [...] disappeared when cell phones appeared."

- **Problem-solving Mindset**: Especially important as systems become more integrated and complex.
- **Skills mobility** and **adaptability** are necessary to cope with workforce shortages and evolving roles.
- **Communication skills**: Needed for liaison with local communities, customers, regulators, and investors. According to P7: *"Operators and engineers need to be able to explain technical issues to management or to local communities. That's often a challenge."*

5.4. Role of Training and Education in Closing the Skills Gap

All interviewees pointed to deficiencies in current training systems and education structures; P4 advocates for using existing resources (e.g., EIT, IESI, Masters+, European SchoolNet, EUREC Masters) rather than "reinventing the wheel."

- There is agreement on the need for training to be flexible, accessible and rapidly deployable, as policy often lags behind actual needs;

- SMEs lack resources to run their own training and rely on external or association-provided schemes, but even mandatory training sees poor attendance;
  - **Lack of planning**: Companies typically focus on technology and market development but neglect human capital planning.

- **Micro-credentials** and **modular training formats** are promising, but recognition systems can be bureaucratic and slow.
  - P1 highlights the importance of **developing flexible, responsive education and training systems** that can adapt as demands evolve. He also warns against relying solely on traditional recognition systems, as they often **lag behind fast-changing industry needs**.

- **Lack of Motivation and Uptake**: "Training exists, but uptake is low due to lack of motivation, cost, and time concerns." There is a critical need for **reskilling and upskilling**, particularly in SMEs, which often struggle to release staff for training. Internal training within companies, often informal but tied to promotion and pay, is effective in addressing skills gaps.
  - P2 also highlights a limited awareness among the young workforce about the nature and requirements of job roles such as heat pump installation, and the need for education, even at the early school levels, to raise awareness of green careers. There is **a lack of awareness** of how technical and rewarding professions can be in the renewable energy sector and **vocational education is undervalued** compared to university paths, many parents steer children away from trades.

- **Internships and Mentorships**: P1 advocated for flexible work and rotation programs. P4 shared successes from internship programs, stating, "Principal Power was having at a point in time more than seven of our interns that are now full-time employees."
  - **Internal mentorship structures** within diverse teams foster natural knowledge transfer.

- **University-Industry Gaps**: "If there is no industry, it's much more difficult to convince universities to do a specific program."
  - **Formal education pipelines** are currently misaligned with emerging industrial needs in PV due to the sector's collapse and rebuild. For instance, P7 highlights that specialised programs tailored to **biogas plant management and safety** are seen as lacking and urgently needed. According to P8 and P9, traditional vocational training programs are perceived as too narrow, focusing mainly on conventional gas systems without preparing for hybrid and renewable

energy integration.

- **Further education** is more connected to local industry needs than higher education, which should focus on research and foresight. **On-the-job training programs** and **vocational courses** are critical for developing plant operators and maintenance teams. According to P8 and P9, there is **needed for Specialised Courses, such as** new training programs specifically for hydrogen-ready systems and hybrid renewable-gas installations.

- **Importance of Lifelong Learning**: Continuous education (short certifications, upskilling programs) is emphasised as necessary due to fast-changing technologies and regulatory frameworks. According to P9, for instance: *"Installers who learned 20 years ago are not prepared for hybrid systems today. Without updated training, they simply can't offer the solutions the market demands."*

- **Universities and companies** must both provide structured leadership training and project-based learning. Partnerships with **technical schools and universities** are needed to create curricula that better align with real-world biogas sector needs.

- **Internships, thesis projects, and rotation programs** are key to connecting students with industry and giving them broad exposure.

- **Cross-Sector Training**: He emphasised synergies between PV and semiconductor sectors: "You can share people who have skills which can be used in both."
  - Education systems must promote **cross-sector training synergies** (e.g., from semiconductors to PV, oil & gas offshore to ocean energy).
  - **Recruitment from adjacent sectors** (e.g., automotive, electronics) is often more effective than retraining existing workers.
  - **University-industry partnerships** work well in **mature sectors** (e.g., wind energy in Navarra), but are underdeveloped in PV and ocean energy.

5.5. Future Skills in Demand

All participants acknowledged evolving skill needs, particularly due to technological advances. Some of the participants agree that there are some currently undervalued skills that may become essential in the future but identifying them requires more input from industry and research partners. Following is a comprehensive list of the future skills in demand according to the participants:

- **AI competency, Digital Transformation and Data Science**: as AI and automation evolve, the fusion of digital literacy with engineering knowledge will be critical. Considering monitoring, control, and safety, AI and automation will reshape these energy-sector job functions, while **Digital transformation skills** will be essential, although the energy sector is still seen as risk-averse and slow to adopt new tech. P3 noted that "Job functions are already being transformed by AI; future workers must understand and work alongside AI systems." There is a need for **Bridging Technical Domains, as** P2 claims: "There is a growing need for technicians capable of bridging energy, digital, and automation systems."
- **Automation and Additive Manufacturing**: (3D printing) and other **innovative production techniques** are expected to become central in renewables. P4 forecasts a demand for new manufacturing technologies: "Innovative manufacturing technologies like additive manufacturing will be in the hot spot."
- **Battery technology**: Especially important for sectors like automotive; institutions must align curricula to this demand.
- **Hydrogen Technology Expertise**: As hydrogen is introduced as a gas substitute, specialised knowledge will be required to install and maintain hydrogen-capable systems.

- **Energy Transition Competencies**: Installers must understand broader energy transition principles, not only technical adaptation but also environmental and efficiency goals, especially within the photovoltaic subsector.
- **Circular economy expertise**: within the biogas subsector especially, understanding how biogas plants can integrate into broader waste management and resource recovery systems will be essential.
- **Compliance and Certification Skills**: within the photovoltaic subsector, regulations are expected to tighten regarding emissions and installation standards, making compliance skills increasingly critical.
- **Knowledge of new regulations**: Particularly related to renewable energy targets, emissions caps, and sustainability reporting.
- **Strategic Foresight and monitoring**: P1 emphasised the need for monitoring future skill needs: "Skills observatories and stakeholder engagement are necessary to anticipate future needs." P2 emphasises “we're only at the **beginning of a major transformation**, especially in the renovation of existing buildings”.
- **Entrepreneurial Mindsets**: According to P3, "Young people are more entrepreneurial, and future systems will rely on innovation-driven mindsets."
- **Diversity of thought**: Future teams must be diverse in culture, discipline, and gender to navigate increasing complexity.
- **Teamwork and intersectoral cooperation skills** are crucial as solving industry problems increasingly requires collaboration across domains.

5.6. Conclusion

The interviews collectively highlight a multifaceted skills challenge facing the renewable energy sector. While each sub-sector presents unique demands, several shared themes emerge: digital proficiency, cross-disciplinary capability, systemic thinking, and a need for modernised, responsive training systems. Strategic coordination between industry, education, and policy will be vital to closing both current and future skills gaps.

6. Assessment on the supply of training

This section presents a comprehensive analysis of the current supply of training courses relevant to the renewable energy sector. A total of 89 courses were identified and evaluated, covering a wide spectrum of technologies and thematic areas aligned with the sector's occupational profiles and skill needs.

6.1. Demographics and Distribution of Courses

6.1.1. Courses by Sector

The courses analysed represent the data points available on renewable energy training offerings. The distribution by sector is as follows:

Table 6: *Number of courses by sector*

Sector	Total Number of courses
Battery Storage (supporting Renewable Energy Systems)	37
Photovoltaic (PV) Solar	16
Solar Energy	10
Renewable Energy Storage	9
Solar Thermal (Concentrating and Non-Concentrating)	4
Heat Pumps	3
Wind Energy	3
Geothermal Energy	3

Other	2
Non-Technological (policy, funding, regulation)	1
Bioenergy/Biomass	1

6.1.2. Courses by Country

Geographically, the majority of courses are offered within Europe, with 68 courses identified as European-wide or country-agnostic in scope. Germany stands out as a key national provider with 12 courses, consistent with its strong industrial and academic base in renewable energy technologies. An additional 6 courses are offered across multiple EU countries, reflecting collaborative or transnational training initiatives. A small number of Europe/Global courses (3) show lower scores, reflecting challenges in addressing diverse regional needs.

Table 7: *Number of courses by country*

Country	Total Number of courses
Europe	68
Germany	12
Europe/Global	3
France	2
Romania	1
Denmark	1

Portugal	1
Spain	1
United Kingdom	1

6.2. Quality of the Training Courses: Criteria and Methodology

The quality and relevance of the 89 courses were evaluated through a multi-criteria scoring system designed to capture both the content alignment with labour market needs and the practical aspects of course delivery. The evaluation considered four primary dimensions:

1. Relevance: This dimension measures the degree to which course content addresses the market's most critical skills. The analysis leveraged a predefined list of the top 20 high-demand skills identified from labour market data, as well as the top 5 key skills per top 20 high-demand occupational role. Courses were scored based on the overlap of their taught skills with these priority skill sets, assessing their direct applicability to current and emerging renewable energy job profiles.

2. Accessibility: This criterion reflects how easily potential learners can access the training, considering factors such as device compatibility (desktop, mobile), linguistic availability (single or multiple languages), geographic reach (local to multinational), financial cost (free to high cost), scheduling flexibility (fixed dates vs open enrollment). Accessibility is crucial for widening participation and ensuring training equity across diverse learner populations. Importantly, since not all factors apply to every delivery mode, each is evaluated in connection with whether the course is offered synchronously, asynchronously, or as a combination of both.

3. Methodology: The pedagogical quality of the courses was assessed by examining the level of learner interactivity (from passive lectures to highly interactive formats), and the balance between theoretical and practical training. Robust assessment and hands-on experience were weighted positively, as these enhance knowledge retention and job readiness.

4. Alignment: This dimension evaluated the degree of formal recognition and currency of the course content. Accreditation status (national to fully recognized international accreditation), level of certification rigor and the frequency of content updates (outdated to regularly reviewed) were considered. Alignment with recognized standards ensures that training credentials are credible and valued by employers.

Each course was assigned normalized scores across these dimensions, which were combined using weighted importance, 40% for relevance, 25% for methodology, 25% for alignment, and 10% for accessibility, to produce a final quality score expressed as a percentage. Due to the limited and sometimes sparse information available in many course descriptions, trust in the data varied, consequently, when data for certain quality criteria were missing or incomplete, those dimensions were assigned reduced weighting accordingly.

Each course received normalized scores across four dimensions: relevance, methodology, alignment, and accessibility. These scores were combined using weighted importance, 40% for relevance, 25% for methodology, 25% for alignment, and 10% for accessibility, to produce a final quality score expressed as a percentage. Although not all courses had the same scoring levels within each dimension, all scores were normalized to ensure equal weight for each level within its dimension. Due to limited or incomplete information in many course descriptions, trust in the data varied; therefore, dimensions with missing data were assigned reduced weights accordingly.

6.3. Results and Key Observations

The courses demonstrate a wide range of quality scores, with average final scores varying notably across sectors and countries.

Sectoral Patterns:

- Renewable Energy Storage leads with the highest average course quality score of approximately 37%, indicating strong alignment with key skills and robust course delivery.
- Wind Energy courses follow closely with an average score around 34%, suggesting solid course quality despite the small number of offerings.
- Photovoltaic (PV) Solar and Other sectors score similarly well, averaging about 32% and 31.5% respectively, reflecting established or interdisciplinary training programs with relevant content.
- Battery Storage (supporting Renewable Energy Systems) courses, although the most numerous, have a somewhat lower average score near 31%, highlighting potential for improving course content or methodology.
- The Non-Technological (policy, funding, regulation) sector scored moderately at around 29.6%, highlighting the importance of complementary non-technical training despite the limited number of courses available.
- Both Solar Thermal (Concentrating and Non-Concentrating) and Solar Energy sectors fall into a mid-range quality bracket, with averages near 29% and 27%, respectively.
- Sectors such as Heat Pumps and Bioenergy/Biomass show lower average scores of approximately 20% and 18%, indicating possible gaps in training quality or relevance.

- Geothermal Energy courses scored the lowest at roughly 12%, suggesting a significant opportunity to strengthen training offerings in this area.

Country Patterns:

- Training offered in Denmark and Spain achieved the highest average scores, approximately 48% and 47% respectively, indicating high-quality and well-aligned programs despite each country having only one course available.
- Portugal and France, with one and two courses respectively, followed with solid average scores around 34% and 33%, reflecting consistent program quality.
- Germany, with 12 courses, represents a larger training hub but scored lower, around 26%, suggesting a more heterogeneous supply where a higher volume of courses does not necessarily guarantee better quality.
- Courses categorized as Europe-wide (67 courses) averaged about 31%, representing offerings targeted across European countries. In contrast, those classified as Europe/Global (3 courses), which are available internationally beyond Europe, had the lowest average score of approximately 18%, possibly reflecting challenges in addressing local relevance or securing accreditation across multiple regions.
- Countries like the United Kingdom and Romania, each with only one course, scored lower (approximately 26% and 24% respectively), indicating room for growth in training availability and quality.

Skills Alignment Insights

High-scoring courses consistently demonstrated strong coverage of the top 20 skills prioritized across the renewable energy labour market. Core competencies such as perform data analysis (present in 14 courses), problem-solving with digital tools (13 courses), encouraging teambuilding (12 courses), project management (11 courses), and renewable energy technologies (10 courses) are highly represented. Additional relevant skills, including carrying out energy management of facilities (8 courses), managing time (7 courses), and communication (6 courses), further characterize these courses.

Beyond these broad market skills, these high-scoring courses also show strong alignment with role-specific skills tied to critical occupations in the sector. For example, skills associated with Wind Turbine Technicians appear prominently in 21 courses, with emphasis on perform data analysis (14 courses), renewable energy technologies (10 courses), and energy management (8 courses). Similarly, Software Developers (20 courses) feature matched skills such as data analysis (14 courses), problem-solving with digital tools (13 courses), and encouraging teambuilding (12 courses).

Other important roles including Senior Software Architects (19 courses), Electrical Engineers (18 courses), and Project Managers (18 courses) reflect comprehensive skill match profiles that span essential technical and soft skills relevant to their job functions.

In contrast, lower scoring courses reveal a narrower and less consistent skill coverage. Notably, eight of these courses showed no matched broad skills at all. Among skills present, critical competencies like project management, renewable energy technologies, and perform data analysis appeared in only five courses each. Other key skills such as problem-solving with digital tools were found in just four courses, while digital programming skills like Python were scarce, present in only one course. Soft skills such as communicating with stakeholders and encouraging teambuilding appeared more frequently but still significantly less than in high-scoring courses.

Role-specific skill alignment in lower scoring courses was also limited. While skills related to key roles like Project Manager (13 courses), Operations Manager (11 courses), and Software Developer (10 courses) were observed, the range and frequency of these associated skills were reduced. The presence of eight courses with no matched role-specific skills highlights a clear gap in relevance. This pattern suggests that many lower scoring courses focus on more general or theoretical content and lack the applied, interdisciplinary elements critical for addressing the evolving demands of the renewable energy labour market.

Overall, the comparison underscores that high-scoring courses provide comprehensive and practical training aligned with both broad labour market skills and role-specific competencies essential for diverse renewable energy occupations. Lower scoring courses show notable gaps in both core skill coverage and relevance to key job roles. This disparity highlights the importance of integrating emerging digital and applied skills to better prepare the workforce for current and future labour market needs.

Expanded Conclusions with Emphasis on Skills Alignment

The data clearly shows a significant disparity between courses that effectively cover the critical skills demanded by the renewable energy labour market and those that do not. While high-scoring courses demonstrate comprehensive alignment with key technical and soft skills, closely matching the needs of important occupational roles, many other courses fall short, exhibiting limited skill coverage and role relevance. This unevenness in skills alignment reveals that simply having a wide variety of courses is not sufficient; courses must also be relevant and well-tailored to market needs to support effective workforce development.

These skills alignment patterns correspond closely with observed sectoral and geographic variations. Sectors such as Renewable Energy Storage and Wind Energy, which have the highest average course quality scores, show stronger coverage of core and role-specific skills, indicating better preparedness to meet labour market demands. Conversely, sectors with lower average scores, including Heat Pumps, Bioenergy/Biomass, and Geothermal Energy, demonstrate weaker alignment with critical competencies and role requirements.

Geographically, countries like Denmark and Spain, with the highest average course quality scores, reflect training offerings with more robust skill integration, while larger training hubs such as Germany present a more heterogeneous supply with greater variability in skills coverage and course relevance. This highlights that skill alignment challenges are both sector-specific and influenced by national training ecosystems and resource availability.

In essence, the quality and relevance of skills content, particularly alignment with actual labour market demands, emerges as the most decisive factor in ensuring that training investments translate into employability and sector growth. The gaps identified in lower scoring courses underscore the risk that without targeted improvements, workforce readiness will remain inconsistent despite broad course availability. This assessment validates that skills alignment is indeed the critical dimension that must be addressed to enhance the impact of renewable energy training across sub-sectors.

Additionally, the analysis reveals that several important and emerging skills remain scarcely represented or completely absent across the training supply. Skills related to automation technology, cloud technologies, civil engineering, and building systems monitoring are notably missing, while programming-related skills such as Python and basic programming appear only sporadically. This gap reflects a broader challenge in integrating advanced digital, interdisciplinary, and specialized technical competencies into renewable energy curricula. The persistent underrepresentation of these skills across both high- and low-scoring courses signals a critical need for curricula updates to better prepare learners for evolving job demands driven by technological innovation and system complexity in the sector.

Recommendations: Prioritizing Skill-Driven Course Enhancement

To effectively address the evolving demands of the renewable energy sector and bridge the gaps identified in current training offerings, policymakers, educators, and training providers should prioritize the following:

1. **Embed Advanced Digital and Interdisciplinary Skills:**
   Curricula must be updated to incorporate programming, automation, cloud technologies, and systems thinking. These skills are crucial to equip learners for integrated energy systems and smart infrastructure, where technical expertise intersects with digital innovation.
2. **Strengthen Core and Emerging Competencies Across Sectors:**
   Focus on ensuring foundational skills, such as data analysis, project management, and renewable energy technologies, are thoroughly covered, especially in lower-scoring sectors like Heat Pumps, Bioenergy/Biomass, and Geothermal Energy. Special attention should be given to underrepresented yet critical skills like Python programming and automation technologies.
3. **Incorporate Soft Skills for Workforce Readiness:**

Enhance training with modules on communication, team collaboration, leadership, and stakeholder engagement. These competencies are essential for effective project execution and innovation within complex renewable energy projects.

4. **Develop Modular and Flexible Learning Pathways:**
   Design training that accommodates varied learner needs, enabling the acquisition of core technical skills alongside specialized competencies through modular formats. This supports lifelong learning and adaptability in a rapidly changing sector.
5. **Improve Accessibility and Inclusivity:**
   Expand multilingual course offerings, leverage mobile-friendly and asynchronous delivery methods, and address financial and scheduling barriers to broaden participation, especially in regions currently underserved by high-quality training.
6. **Foster Industry Collaboration and Continuous Content Updates:**
   Establish strong partnerships between training providers and renewable energy industry stakeholders to ensure courses remain aligned with technological advances, regulatory changes, and labour market priorities.

Standardize Quality Assurance and Accreditation: Promote widely recognized accreditation schemes that emphasize both rigorous skill content and pedagogical quality, enhancing employer confidence and learner motivation.

Final Reflection

This assessment underscores a fundamental truth: **skills alignment is the linchpin of effective renewable energy workforce development.** While the availability of diverse courses is important, it is the relevance and quality of their skill content—closely matched to real-world labour market demands—that ultimately determines their impact on employability and sector growth.

The notable variation across sectors and countries in course quality and skill coverage highlights the need for targeted strategies that address both content gaps and contextual challenges. Without deliberate action to integrate emerging digital and applied skills, and to tailor learning to evolving occupational roles, the renewable energy sector risks persistent workforce shortages and uneven preparedness.

Moving forward, training design must be agile, forward-looking, and inclusive, prioritizing both technical mastery and the soft skills essential for collaboration and innovation. Only by centering skills' relevance within the training ecosystem can Europe’s renewable energy ambitions be fully realized, fostering a resilient, competent, and adaptable talent pipeline for the energy transition ahead.

7. Conclusions

The renewable energy sector across Europe is undergoing a profound transformation, driven by technological innovation, regulatory evolution, and economic restructuring in the pursuit of climate neutrality. The comprehensive analysis undertaken through surveys, job postings, industry reports and stakeholder interviews offers a coherent and evidence-based picture of current and emerging skills needs, and highlights the systemic challenges that must be addressed to ensure a successful energy transition.

The starting point of WP2 is represented by a number of pre-selected profiles that served as a baseline for structured analysis, grounded in job boards data collection, stakeholder interviews, sectoral studies, and surveys conducted in 2023 and 2025. Once those were taken into account, an initial analysis of available industry and market reports was applied to gather information related to existing occupational profiles, with several emerging consistently across the industry and market reports. Among them, Renewable Energy Technicians, Industrial Engineers, Energy Engineers, and Factory Operatives emerged as the occupational groups most consistently cited as critical to renewable energy deployment.

In addition to the predefined occupational profiles (see p.4-7), the initial analysis of reports highlighted an additional set of roles which were not part of the previously identified roles in demand, suggesting a broader scope of relevant workforce categories, including:

- Project managers especially within offshore wind and hydrogen projects
- Offshore marine crew
- Welders, mentioned in relation to turbine blade repair and structural assembly
- Retrofitting experts, mentioned in relation to building energy renovation and heat pump deployment
- Agricultural logistics coordinators and agronomists appeared in connection with bioenergy and feedstock supply chains.

While this initial analysis served as validation for previously identified job roles, and a general feel for emerging roles, the next step in the report has been to analyse findings from both job board data, with thousands of postings, the surveys (2023 and 2025), and responses from interviews of industry stakeholders across Europe.

7.1. Summary of findings across data analysis

7.1.1. Job roles in demand

Both surveys (2023 and 2025) highlighted a sector growing in technical complexity, diversifying in role requirements,

and showing a critical shortage of technical professionals, particularly in roles such as:

- **Renewable Energy Technicians**
- **Gas Technicians**
- **Energy Engineers**

These are not peripheral positions; they are foundational to project execution, system reliability, and lifecycle management. Equally significant is the rise of new, hybrid, and interdisciplinary job profiles. In 2023, the emergence of roles like Software Developers, Mechatronics Engineers, and Digital Modelling Experts highlighted a shift toward the integration of physical and digital systems. By 2025, this evolution had accelerated, with open-ended responses identifying demand for SCADA Programmers, AI specialists, Sustainability Experts, and Cross-Carrier Energy System Planners. These newer roles reflect a workforce increasingly expected to operate at the intersection of energy engineering, data analysis, automation, and regulatory compliance. Gaps persist in areas like automation control, safety and regulatory knowledge, and digital integration, which are essential to scaling smart infrastructure across technologies and jurisdictions.

To strengthen these results further, interviews have highlighted demand for roles across the renewable energy sector, in particular in the wind and solar subsectors, as well as heat pump installation, and biogas and biomethane subsectors. Most urgent needs are for technical roles, like heat pump installers, plant operators and technicians within biogas and biomethane, gas installers and renewable energy technicians, as well as energy efficiency specialists. The findings across all data and renewable energy subsectors have also identified the need for roles such as Project Managers, Site managers, Compliance Officers, and Researchers, which require in-depth knowledge of the country legislation and continuous learning to keep up with changes in the sector.

There are common challenges across the subsectors when it comes to filling these job roles, starting from a lack of interest and limited knowledge about the nature and professional requirements of these roles within young generations, together with a mismatch between the education and training system and job requirements. Moreover, more support from government and associations needs to be available, to allow businesses to upskill and reskill their employees with better training solutions.

7.1.2. Skills in Demand: Technical, Digital, and Transversal Competencies

Skills needs analysis reveals a convergence across sectors:

- **Technical skills** related to installation, maintenance, process optimisation, and systems design remain foundational.

- **Digital skills**, particularly data analysis, basic programming, and digital system integration, are rising rapidly in importance across roles that were once purely mechanical or operational.
- **Soft skills** such as critical thinking, project management, stakeholder communication, and adaptability are increasingly viewed as indispensable.

The gap between industry needs and formal training provision is particularly acute in areas where **digital and technical domains intersect**. Stakeholders repeatedly emphasised the need for engineers and technicians who are not only competent in their traditional domains but are also digitally literate and systems oriented.

7.1.3. The Role of Training and Education

Training systems, both vocational and higher education, were found to be **lagging behind industry needs**. Surveys and interviews highlighted that:

- **Current training provision** often focuses too narrowly on traditional systems, without sufficiently preparing learners for hybrid, digital, and cross-sectoral realities.

- **Lifelong learning, micro-credentials, and modular formats** are needed to allow rapid upskilling and reskilling, particularly in SMEs, where resource constraints limit traditional training investments.

- Challenges related to credential recognition among different EU member states and the need to address mobility issues within skilled workforce are a topic to be investigated with further research.

- **Internships, mentorships, and industry-university collaboration** are critical to developing a workforce that can bridge academic learning with practical, system-wide challenges.
- Interviews, in particular, have highlighted the persistent undervaluation of vocational paths as a barrier to talent development, and the need for **targeted programs** to promote the importance of careers in the renewable energy sector, and the multitude of skills involved in them, among young people in schools.

7.1.4. Future Skills Needs

The forward-looking analysis across methods points to a significant evolution in skills demand, driven by:

- **Technological innovation**, especially AI, digitalisation, additive manufacturing, and hydrogen technologies.
- **Regulatory tightening**, demanding greater compliance, safety management, and environmental

monitoring expertise.

- **Economic transitions**, such as supply chain localisation and circular economy integration.

Future workers will need to combine technical depth with strategic foresight, digital literacy with system-level thinking, and specialised expertise with interdisciplinary flexibility. Profiles such as Energy Transition Strategists, Circular Economy Specialists, and Cross-Carrier Energy Planners are expected to rise in importance alongside traditional engineering and operational roles.

The evidence collected paints a clear picture: the renewable energy sector's skills needs are dynamic, expanding, and increasingly complex. Addressing these needs demands a coordinated response across industry, education, and policy actors. Without a modernised, flexible, and responsive training ecosystem, the pace of technological deployment may be constrained by human capital bottlenecks.

Alongside the evolving skills and role demands, the assessment of the current training supply reveals critical structural factors influencing workforce readiness. A comprehensive evaluation of 89 renewable energy courses highlights uneven distribution across sectors and countries, with marked variability in course quality and alignment with labour market needs. Sectorally, Renewable Energy Storage and Wind Energy exhibit the highest average course quality scores, approximately 37% and 34%, respectively, indicating strong integration of core and role-specific skills and robust pedagogical delivery. In contrast, sectors such as Heat Pumps, Bioenergy/Biomass, and Geothermal Energy show significantly lower average scores (ranging from 12% to 20%), underscoring gaps in course availability, relevance, and practical skill emphasis.

Geographically, countries like Denmark and Spain stand out with fewer but high-quality courses, averaging near 48% and 47%, reflecting well-aligned training ecosystems despite limited offerings. Larger training hubs such as Germany, with more numerous courses (12), present a broader yet more heterogeneous supply, averaging around 26%, which suggests the need for enhanced coordination, quality assurance, and focus on skill relevance. Europe-wide courses form the bulk of the catalog (67 courses), averaging around 31%, but Europe/Global courses show the lowest average quality near 18%, hinting at challenges in balancing broad accessibility with local labour market specificity.

The multidimensional quality evaluation, encompassing relevance, methodology, accreditation alignment, and accessibility, reveals that many courses lack comprehensive coverage of critical emerging skills. While high-scoring courses robustly cover foundational competencies like data analysis, project management, renewable energy technologies, and soft skills such as teambuilding and communication, many offerings fall short in areas including digital programming (e.g., Python), automation, cloud technologies, and system-level interdisciplinary skills. Notably, eight courses showed no matched broad skills, and a similar number lacked any role-specific skill alignment, signaling a persistent gap in practical and applied training components necessary for evolving sector demands.

This supply-side insight confirms that merely expanding the number of courses is insufficient. Targeted

enhancements in course content, particularly embedding advanced digital and interdisciplinary skills, combined with improvements in delivery methodologies and accessibility, are vital to fully prepare Europe's renewable energy workforce. Addressing these gaps in alignment and quality is critical to closing the disconnect between training provision and real-world labour market needs, thereby ensuring that workforce readiness keeps pace with the sector's rapid transformation.

The findings of Work Package 2 provide a critical foundation for future project activities aimed at developing training programs and certifications (WP3), implementing training programs (WP4), promoting careers in the renewable energy sectors (WP5) and ensuring long term impact (WP6). Ensuring alignment with real-world labour market needs will be essential to unlocking Europe's full potential in the global clean energy transition.

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Annexe 1

2023 Survey questionnaire

The 2023 Renewable Energy Skills Partnership survey presented 16 questions that varied slightly across participating sectors. While the core structure was the same, each sector adapted the wording and emphasis of certain questions to reflect their unique operational realities. Despite these differences, the overarching themes and question categories remained aligned.

General Profile Questions

1. **Name of the company/organisation/research centre/university department**
2. **Country**
3. **Where do you locate your firm/organisation in the renewable energy value chain?**
   (e.g. Substrate providers, Equipment manufacturers, Operators of production plants, etc.)
4. **How many staff does your organisation have?**

Job and Skills Needs Today

5. **Name 3–5 of the most important typical job profiles in your organisation today.**
6. **For each of the most important job profiles, how difficult is it to fill the position with qualified workers?**
   (Scale: 1 - Not difficult, 2 - Irregular challenges, 3 - Somewhat difficult, 4 - Difficult, 5 - Very difficult)
7. **Has your organisation faced any of the following recruitment challenges for these roles in the past 2–3 years?**
   a. a) Yes, candidates did not have the appropriate education
   b. b) Yes, candidates had insufficient professional experience
   c. c) Yes, not enough applications were received
   d. d) No
   e. e) Other (please specify)
8. **Which occupations or jobs are the most difficult to fill with qualified workers?**
   (Open-ended / multiple choice)
9. **Does your company have a training scheme for new staff?**
   a. Internal training (specify title & duration)
   b. Outsourced training (specify title, duration, institution)
   c. A combination of both
   d. No

10. **Have you identified any groups that are most in need of training in the short term?**

    (e.g. technicians, operators, engineers, research scientists, etc.)

11. **Is there another area where you have identified skill or knowledge gaps? If yes, please specify.**

    (Open-ended)

Job and Skills Needs in the Near Future

12. **For each of the current typical job profiles, do you anticipate:**
    a. New job openings?
    b. Changes in profile requirements and needed skills/competencies?

    (If yes, specify profiles and skills needed)

13. **What do you think will be the biggest developments influencing industry growth and job creation in the next 2–5 years?**

    (Open-ended)

14. **Considering the above changes, what are the key competencies critical to your organisation's success in the coming 2–5 years?**

    (Open-ended)

15. **In light of the current or emerging skills shortage, from which sectors would you consider recruiting transferable skills or competencies?**

    (Please list sector and transferable skill set)

16. **Which policy measures or regulations (regional/national/EU level) could help address the skills shortage in your sector?**

    (Open-ended)

2025 Survey questionnaire

General Profile Questions

1. **Which of the following best describes your current job role or the job role you represent?**
    a. Government / Policy Maker
    b. Engineer (Renewable Energy Consultant, Energy Engineer, Industrial Engineer)
    c. Manufacturing Professional (Factory Operative, Technician)
    d. Electrical Professional (Domestic or Industrial Electrician)
    e. Technician (Renewable Energy, HVAC, Gas Technician, Geothermal Driller)
    f. Operations & Maintenance Professional (RE Power Plant Operator)
    g. Health & Safety Professional

h. Legal / Regulatory / Administrative Role
i. Educator / Trainer
j. Researcher
k. Other:

2. **In which country is your organisation or membership headquartered?**

3. **What type of organisation do you work for?**
   a. Private Company (Small-Medium Enterprise)
   b. Private Company (Large Corporation)
   c. Trade association
   d. Non-Profit Organisation
   e. Educational Institution (University, Training Center)
   f. Research Centre
   g. Regulatory Authority
   h. Funding Agency
   i. Other:

4. **Which renewable energy sector(s) are you primarily involved in?** (Select all that apply)
   a. Solar Energy
   b. Wind Energy
   c. Geothermal Energy
   d. Bioenergy / Biomass
   e. Heat Pumps
   f. Renewable gas (hydrogen, biogas)
   g. Renewable energy storage
   h. Photovoltaic (PV) Solar
   i. Solar Thermal (Concentrating and Non-Concentrating)
   j. Battery Storage (supporting Renewable Energy systems)
   k. Non-Technological (e.g. policy, funding, regulation)
   l. Other:

5. **How many years of experience do you have in the renewable energy sector?**
   a. Less than 1 year
   b. 1–3 years

c. 4–6 years
d. 7–10 years
e. 10+ years

Occupational Profiles

6. **How difficult is it to find qualified professionals for each of the following occupational profiles?**

   (Each profile is answered using the options below)

   a. Easy to find
   b. Moderately difficult
   c. Hard to find
   d. Doesn't apply

Occupational profiles include:

e. Government: Urban Planner / Energy Manager / Regulator
f. Engineering: Renewable Energy Consultant
g. Engineering: Energy Engineer
h. Manufacturing: Factory Operative / Maintenance Technician
i. Manufacturing: Industrial Engineer
j. Electrical: Domestic Electrician
k. Electrical: Industrial Electrician
l. Technicians: Renewable Energy Technician (Wind, Solar, Geo, Heat Pumps)
m. Technicians: Gas Technician (Biogas, Hydrogen)
n. Technicians: HVAC & Refrigeration Technician
o. Operations: REPower Plant Operator
p. Health & Safety: Health & Safety Professional
q. Disposal: Critical Raw Material Recovery Specialist

7. **For each of the same profiles, what is the demand outlook?**

   a. Currently in demand
   b. Expected to be in demand (near future)
   c. Not in demand
   d. Doesn't apply

8. **Are there any other occupational profiles relevant to your organisation or in future demand?**

   (Open-ended)

Design Skills

9. **How difficult is it to find professionals with the following design-related skills?**

   (Options: Easy to find, Moderately difficult, Hard to find, Doesn't apply)

   a. Renewable energy engineering
   b. Renewable energy technologies
   c. System design (digital)
   d. Modelling and simulation
   e. Project management
   f. Sustainable design
   g. Administrative, legal, and digital skills for permitting

10. **Are the above design-related skills in demand?**

    (Options: Currently in demand, Expected to be in demand, Not in demand, Doesn't apply)

Production Skills

11. **How difficult is it to find professionals with the following production-related skills?**

    (Same 4-point scale as above)

    a. Renewable energy manufacturing processes
    b. Materials used in renewable energy systems
    c. Mechanical skills
    d. Quality control
    e. Problem solving and diagnostics
    f. Digital skills (CAD / AR)
    g. Programming industrial computers and sensors

12. **Are the above production-related skills in demand?**

    (Same 4-point scale as above)

Installation Skills

13. **How difficult is it to find professionals with the following installation-related skills?**

    (Same 4-point scale as above)

    a. Electrical engineering
    b. HVAC engineering
    c. System design and sizing
    d. System installation
    e. Commissioning and troubleshooting
    f. Renewable energy project management

g. Best practices for system installation, monitoring

14. **Are the above installation-related skills in demand?**

(Same 4-point scale as above)

Operation & Maintenance (O&M) Skills

15. **How difficult is it to find professionals with the following O&M skills?**

(Same 4-point scale as above)

a. Safety protocols and permits
b. Standards and regulations
c. Diagnostic tools and system analysis
d. Energy management
e. Environmental impact
f. Electrical and HVAC systems
g. Refrigerant leak detection

16. **Are the above O&M skills in demand?**

(Same 4-point scale as above)

Disposal & Circularity Skills

17. **How difficult is it to find professionals with the following disposal/circularity skills?**

(Same 4-point scale as above)

a. Circularity of renewable energy technologies
b. Life cycle assessments
c. HVAC in disposal phase
d. Safety and regulatory standards
e. New business ecosystems
f. Transition management

18. **Are the above disposal & circularity skills in demand?**

(Same 4-point scale as above)

Final Questions

19. **Are there any other skills or competences not listed above that are relevant to your organisation or in future demand?**

(Open-ended)

20. **Would you be open to a follow-up interview? If yes, please provide your email.** *(Open-ended)*

Annexe 2

Qualitative Interview guide

Section 1: Demographic Information

1. What is your current job role? How many years have you been in this role?
2. How many years of experience do you have in the renewable energy sector altogether?
3. Which renewable energy sector(s) are you primarily involved in?
4. What type of organization do you work for (e.g., Private SME, large company, government, trade association, nonprofit, academic institution)?
5. Which country/region do you work in primarily?
6. What is the size of your organization in terms of employees?
7. What is your highest level of education, and do you have any specialized training in renewable energy?

Section 2: Jobs in demand, Skills Gaps and Workforce Development

1. Are there specific job roles in your organisation/association/sector which are difficult to fill with qualified workers? Can you specify them?
2. The survey identified certain technical skills shortages. Can you discuss which skills are most critical for your organization and how you are addressing these shortages?
3. Are there any non-technical (soft) skills that are particularly important in your industry? If so, which ones and why?
4. Are you experiencing challenges in recruiting professionals with the necessary skills? If so, what are the biggest barriers?
5. What role do apprenticeships, internships, or university partnerships play in bridging skills gaps within your organization?
6. Are there any skills that are currently undervalued but might become essential in the near future?

Section 3: Adapting to Change and Future Planning

1. How well does your organization respond to changing skills needs driven by industry trends or technological advancements? What factors support or hinder this adaptability?
2. What skills do you anticipate needing most in the next 2-3 years, and how are you planning to acquire them?
3. How do you balance long-term workforce planning with short-term operational demands?
4. Have automation and digital tools impacted the way your workforce is structured? If so, how?

Section 4: Organizational Approaches and Strategies

1. Which initiatives (internal training, external certifications, mentorship) have been most effective in closing skills gaps? What improvements could be made?
2. What strategies are you considering to mitigate future skills shortages? Do you see more value in developing internal talent or hiring externally?

3. How do you measure the effectiveness of workforce training and development programs?
4. Are there any workforce strategies from other industries that you think could be applied to renewable energy?
5. How do diversity and inclusion efforts factor into your organization’s workforce planning and skills development?